Einhorn
Yaffee
Prescott

ARCHITECTURE &
ENGINEERING, P.C.

~~OCTOBER 16, 1987~~ 7/88

BALTIMORE CORPS OF ENGINEERS

FORT DIX, NEWJERSEY

ENERGY SAVINGS OPPORTUNITY STUDY

ENERGY ENGINEERING ANALYSIS PROGRAM

CONTRACT NO. DACA-31-85-0166

FINAL REPORT

EXECUTIVE SUMMARY

THE ARGUS BUILDING
BROADWAY AT BEAVER
POST OFFICE BOX 617
ALBANY, NY 12201-0617
(518) 463-2141

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

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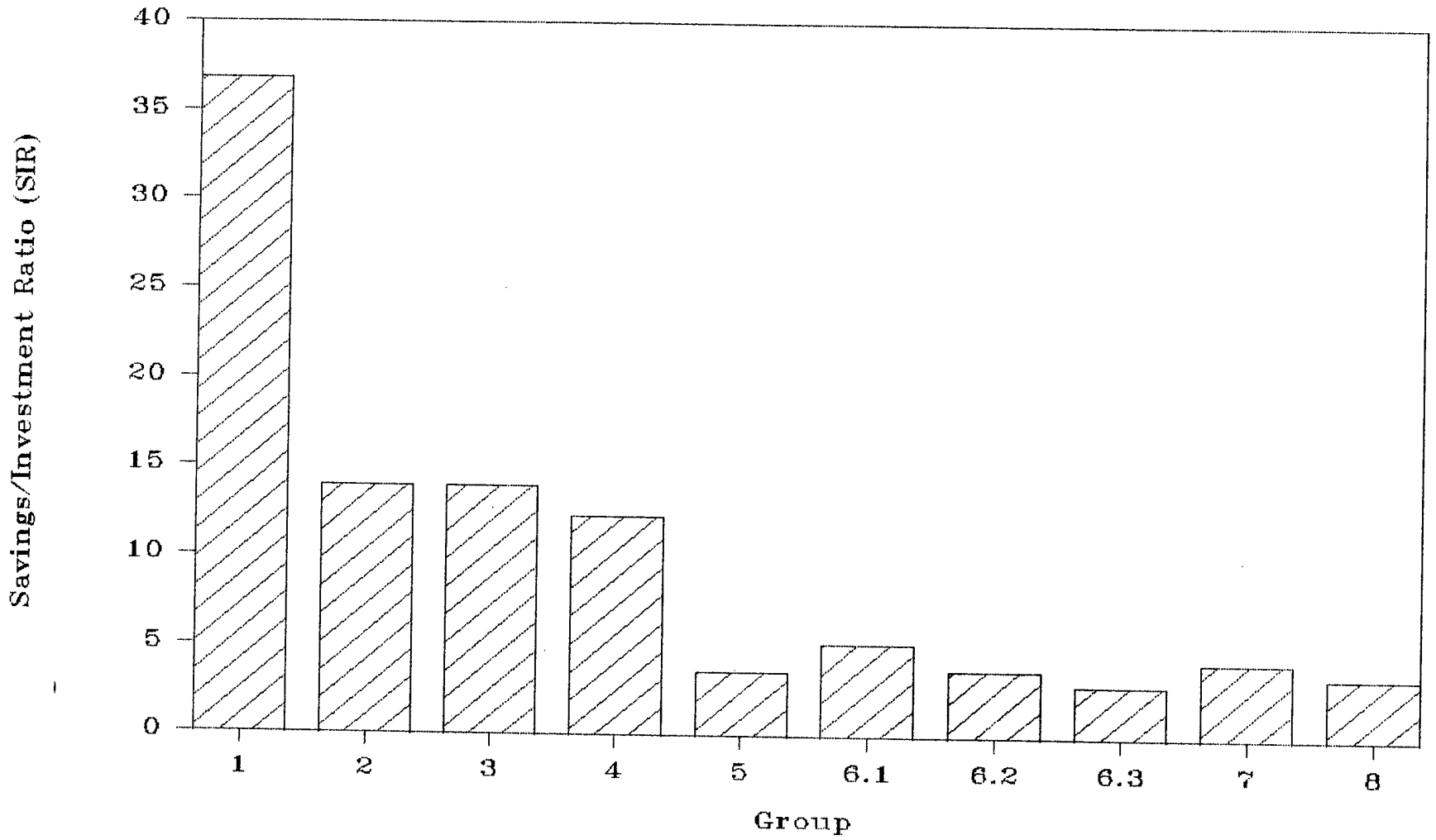

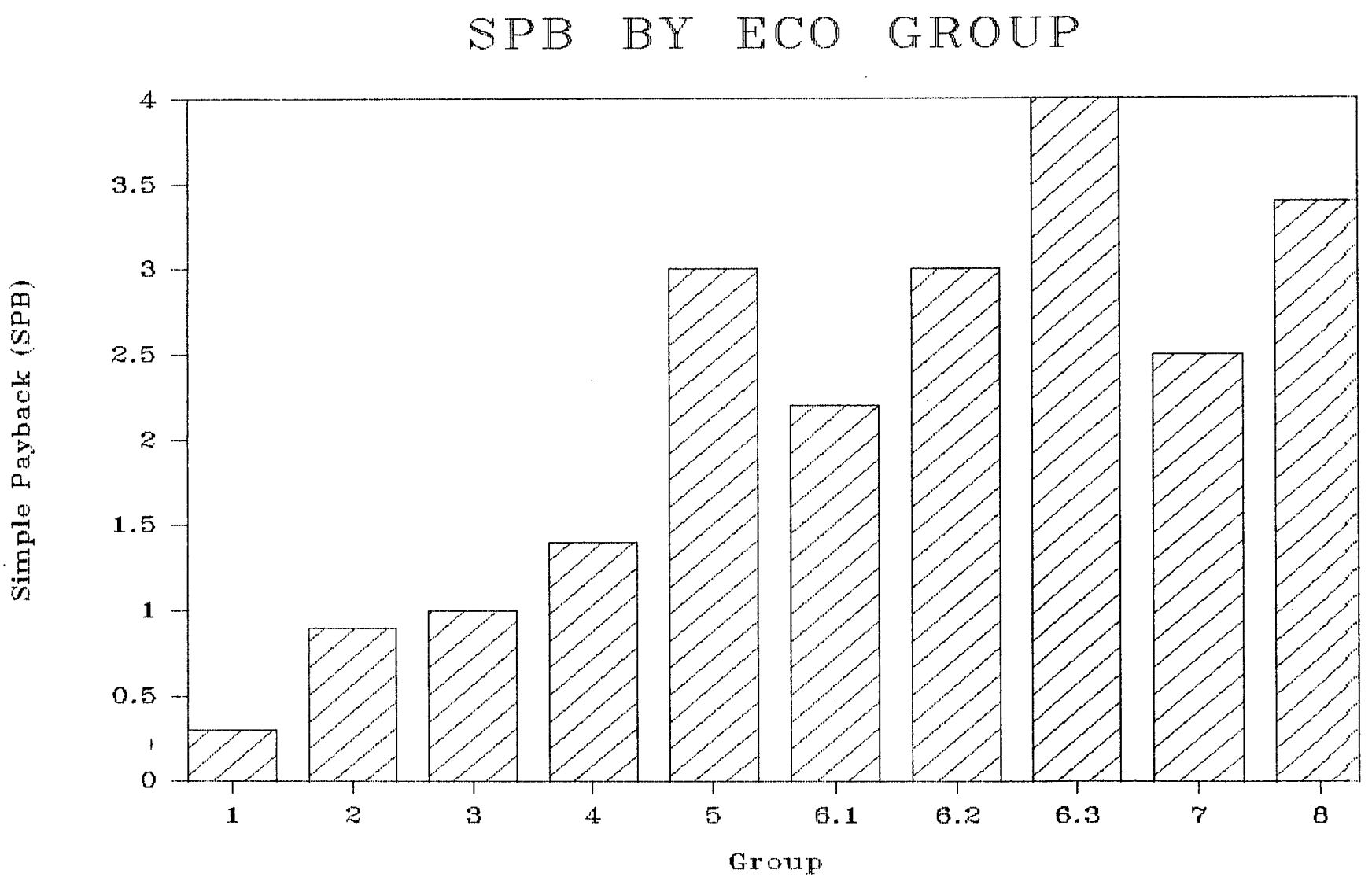
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FORT DIX, NEW JERSEY

ENERGY SAVINGS OPPORTUNITY SURVEY

ENERGY ENGINEERING ANALYSIS PROGRAM

FOR

DEPARTMENT OF THE ARMY

BALTIMORE DISTRICT CORPS OF ENGINEERS

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EXECUTIVE SUMMARY

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INTRODUCTION

In October of 1985, the firm of Einhorn Yaffee Prescott, P.C. was retained by the Army Corps of Engineers to perform an energy savings opportunity survey of 63 buildings at Fort Dix, New Jersey. The scope of this study included the following work:

- Evaluate selected energy conservation opportunities (ECO's) to determine their energy savings potential and economic feasibility.
- Perform a limited site survey of selected buildings or areas to insure that any new methods of energy conservation which are practical and have not been evaluated in any previous energy study have been considered and the results documented.
- Provide complete new programming or implementation documentation for all recommended ECO's.
- Prepare a comprehensive report to document the work performed, the results and the recommendations.

With this prefinal submittal approximately 95% of the work required by the scope has been completed.

The Executive Summary contains the following material:

- A brief description of previous energy efforts at Fort Dix and the way this survey was conducted.
- Graphical Energy History.
- Chart of recommended projects with economic justification.
- A brief description of each component ECO in the individual projects with economic summaries.

For a more comprehensive treatment of the results of this ESOS refer to the five volume Narrative Report. These volumes deal with the physical characteristics of each of the sixty three buildings surveyed, their apparent deficiencies, the ECOs studied and recommended to improve their energy performance. Included in this work is an energy savings calculation for each researched ECO with associated ECIP life cycle economics.

The ten recommended projects have been included in the programming documents where a form DD 1391 has been prepared for each along with a 1391 for each individual ECO within the project.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

OPERATION AND MAINTENANCE ITEMS

Building Name	Building Number	Energy Saving Opportunity	ECO Number	CARPENTER HOURS	ELECTRICIAN HOURS	PLUMBER HOURS
Water Filtration Plant	99	Reduce Infiltration	46.0	3		
General Purpose Warehouse	3134	Multi-Set Back	28.1		3	
Thrift Shop	3280	Piping Insulation	2.0	10		
Hangar	4433	Multi-Set Back	28.1		5	
Hangar	4433	Revise Boiler Controls	49.0	2	16	
Transport Div	5139	Piping Insulation	2.0	64		
Transport Div	5139	Personnel Door Weatherstrip	7.0	12		
Transport Div	5139	HW Temp Reduction	14.0		1	
Transport Div	5139	Multi-Set Back	28.1		2	
Transport Div	5139	Reduce Lighting Levels	39.0		8	
Transport Div	5139	Reduce Lighting Levels	39.1		10	
Transport Div	5139	Return Condensate	51.0			3
Provost Marshall	5210	Piping Insulation	2.0	5		
Provost Marshall	5210	HW Temperature Reduction	14.0		1	
Supply Serv. Admin	5211	Personnel Door Weatherstrip	7.0	12		
Supply Serv. Admin	5211	HW Temperature Reduction	14.0		1	
Supply Serv. Admin	5211	Multi Set Back	28.2		2	
Main Chapel	5240	Reduce Lighting Levels	39.0		1	
Main Chapel	5240	Reduce Infiltration	46.0	10		
BOQ	5254	Piping Insulation	2.0	4		
BOQ	5254	HW Temperature Reduction	14.0		1	
BOQ	5254	Multi-Set Back	28.2		2	
BOQ	5254	Reduce Lighting Levels	39.0		1	
Nurse's Quarters	5256	Piping Insulation	2.0	24		
Nurse's Quarters	5256	HW Temperature Reduction	14.0		1	
Nurse's Quarters	5256	Return Condensate	51.0			4
DEH Supply/NYCE	5317	Duct Insulation	1.0	18		
DEH Supply/NYCE	5317	Piping Insulation	2.0	5		
DEH Supply/NYCE	5317	Multi-Set Back	28.2		2	
DEH Admin Bldg	5320	Piping Insulation	2.0	6		
DEH Admin Bldg	5320	HW Temperature Reduction	14.0		1	
DEH Admin Bldg	5320	Reduce Lighting Levels	39.0		3	
DEH Admin Bldg	5320	Reduce Infiltration	46.0	3		
Enlisted Men's Barracks	5401	Piping Insulation	2.0	28		
Enlisted Men's Barracks	5401	Personnel Door Weatherstrip	7.0	10		
Enlisted Men's Barracks	5401	HW Temperature Reduction	14.0		1	
Enlisted Men's Barracks	5401	Multi-Set Back	28.1		2	
Enlisted Men's Barracks	5401	Reduce Lighting Levels	39.0		3	
Enlisted Men's Barracks	5404	Piping Insulation	2.0	32		
Enlisted Men's Barracks	5404	Personnel Door Weatherstrip	7.0	8		
Enlisted Men's Barracks	5404	HW Temperature Reduction	14.0		1	
Enlisted Men's Barracks	5404	Multi-Set Back	28.1		2	
Enlisted Men's Barracks	5404	Reduce Lighting Levels	39.0		4	
Enlisted Men's Barracks	5406	Piping Insulation	2.0	32		

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

OPERATION AND MAINTENANCE ITEMS

Building Name	Building Number	Energy Saving Opportunity	ECO Number	CARPENTER HOURS	ELECTRICIAN HOURS	PLUMBER HOURS
Enlisted Men's Barracks	5406	Personnel Door Weatherstrip	7.0	8		
Enlisted Men's Barracks	5406	HW Temperature Reduction	14.0		1	
Enlisted Men's Barracks	5406	Reduce Lighting Levels	39.0		4	
Brigade Classroom	5411	Piping Insulation	2.0	5		
Brigade Classroom	5411	HW Temperature Reduction	14.0		1	
Brigade Classroom	5411	Multi-Set Back	28.1		6	
DIO Administration	5418	Piping Insulation	2.0	32		
DIO Administration	5418	Personnel Door Weatherstrip	7.0	16		
DIO Administration	5418	HW Temperature Reduction	14.0		2	
DIO Administration	5418	Multi-Set Back	28.1		4	
DIO Administration	5418	Reduce Lighting Levels	39.0		16	
Dispensary	5429	Duct Insulation	1.0	12		
Dispensary	5429	Piping Insulation	2.0	8		
Dispensary	5429	HW Temperature Reduction	14.0		1	
Dental Clinic	5437	Piping Insulation	2.0	4		
Dental Clinic	5437	HW Temperature Reduction	14.0		1	
Dental Clinic	5437	Multi-Set Back	28.1		3	
Dental Clinic	5437	Reduce Lighting Levels	39.0		16	
NCO Open Mess	5455	Piping Insulation	2.0	36		
NCO Open Mess	5455	Personnel Door Weatherstrip	7.0	10		
NCO Open Mess	5455	HW Temperature Reduction	14.0		1	
NCO Open Mess	5455	Multi-Set Back	28.1		3	
Brigade/Classroom	5505	Piping Insulation	2.0	4		
Brigade/Classroom	5505	Personnel Door Weatherstrip	7.0	10		
Brigade/Classroom	5505	Multi-Set Back	28.1		6	
Enl. Men Barracks	5506	Piping Insulation	2.0	26		
Enl. Men Barracks	5506	Personnel Door Weatherstrip	7.0	10		
Enl. Men Barracks	5506	HW Temperature Reduction	14.0		1	
Enl. Men Barracks	5508	Piping Insulation	2.0	28		
Enl. Men Barracks	5508	Personnel Door Weatherstrip	7.0	2		
Enl. Mens Barracks	5515	Piping Insulation	2.0	14		
Enl. Mens Barracks	5515	Personnel Door Weatherstrip	7.0	9		
Enl. Mens Barracks	5515	Multi-Set Back	28.1		2	
Enlisted Men's Mess Hall	5601	Duct Insulation	1.0	24		
Enlisted Men's Mess Hall	5601	Piping Insulation	2.0	24		
Enlisted Men's Barracks	5602	Piping Insulation	2.0	18		
Enlisted Men's Barracks	5602	HW Temperature Reduction	14.0		1	
Battalion Headquarters	5605	Duct Insulation	1.0	10		
Battalion Headquarters	5605	Piping Insulation	2.0	12		
Battalion Headquarters	5605	Personnel Door Weatherstrip	7.0	8		
Battalion Headquarters	5605	HW Temperature Reduction	14.0		1	
Battalion Headquarters	5605	Return Condensate	51.0			
Battalion Headquarters	5614	Piping Insulation	2.0	10		
Battalion Headquarters	5614	HW Temperature Reduction	14.0		1	

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

OPERATION AND MAINTENANCE ITEMS

Building Name	Building Number	Energy Saving Opportunity	ECO Number	CARPENTER HOURS	ELECTRICIAN HOURS	PLUMBER HOURS
Battalion Headquarters	5614	Reduce Lighting Levels	39.0		3	
Brigade Gym	5631	Piping Insulation	2.0	8		
Brigade Gym	5631	HW Temperature Reduction	14.0		1	
Brigade Headquarters	5634	Piping Insulation	2.0	12		
Brigade Headquarters	5634	Personnel Door Weatherstrip	7.0	4		
Brigade Chapel	5635	Piping Insulation	2.0	1		
Brigade Chapel	5635	Personnel Door Weatherstrip	7.0	12		
Brigade Chapel	5635	Return Condensate	51.0			3
Enlisted Men's Mess Hall	5640	Duct Insulation	1.0	10		
Enlisted Men's Mess Hall	5640	Piping Insulation	2.0	20		
Enlisted Men's Mess Hall	5640	Personnel Door Weatherstrip	7.0	5		
Admin/Storage	5643	Piping Insulation	2.0	8		
Admin/Storage	5643	Personnel Door Weatherstrip	7.0	3		
Reception Center	5656	Duct Insulation	1.0	100		
Reception Center	5656	Piping Insulation	2.0	80		
Reception Center	5656	Personnel Door Weatherstrip	7.0	16		
Reception Center	5656	HW Temperature Reduction	14.0		1	
Reception Center	5656	Return Condensate	51.0		8	6
Dental Clinic	5660	Piping Insulation	2.0	10		
Enlisted Men's Barracks	5702	Piping Insulation	2.0	20		
Enlisted Men's Barracks	5702	HW Temperature Reduction	14.0		1	
Enlisted Men's Barracks	5702	Reduce Infiltration	46.0	68		
Enlisted Men's Barracks	5702	Return Condensate	51.0		6	10
Admin/Storage	5713	Duct Insulation	1.0	4		
Admin/Storage	5713	Piping Insulation	2.0	10		
Admin/Storage	5713	Return Condensate	51.0		2	4
Motor Repair Shop	5720	HW Temperature Reduction	14.0		1	
Motor Repair Shop	5720	Multi-Set Back	28.1		3	
Brigade Gym	5731	Duct Insulation	1.0	25		
Brigade Gym	5731	Piping Insulation	2.0	12		
Brigade Gym	5731	Return Condensate	51.0		2	8
Battalion Headquarters	5734	Piping Insulation	2.0	10		
Battalion Headquarters	5734	Reduce Lighting Levels	39.0		2	
Battalion Headquarters	5734	Return Condensate	51.0			3
Enlisted Men's Mess Hall	5740	Duct Insulation	1.0	30		
Enlisted Men's Mess Hall	5740	Piping Insulation	2.0	18		
Enlisted Men's Mess Hall	5740	Return Condensate	51.0		2	8
Enl Men Ser Club	5756	Duct Insulation	1.0	26		
Enl Men Ser Club	5756	Piping Insulation	2.0	16		
Enl Men Ser Club	5756	HW Temperature Reduction	14.0		1	
Enl Men Ser Club	5756	Reduce Lighting Levels	39.0		2	
Enl Men Ser Club	5756	Return Condensate	51.0		8	12
Enlisted Men's Mess Hall	5801	Duct Insulation	1.0	32		
Enlisted Men's Mess Hall	5801	Piping Insulation	2.0	22		

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

OPERATION AND MAINTENANCE ITEMS

Building Name	Building Number	Energy Saving Opportunity	ECO Number	CARPENTER HOURS	ELECTRICIAN HOURS	PLUMBER HOURS
Enlisted Men's Mess Hall	5801	Personnel Door Weatherstrip	7.0	5		
Enlisted Men's Barracks	5802	Piping Insulation	2.0	26		
Battalion Headquarters	5805	Piping Insulation	2.0	10		
Battalion Headquarters	5805	Personnel Door Weatherstrip	7.0	8		
Battalion Headquarters	5805	Air Volume Reduction	21.0	5		
Exchange Branch	5832	Piping Insulation	2.0	6		
Exchange Branch	5832	Personnel Door Weatherstrip	7.0	8		
Exchange Branch	5832	HW Temperature Reduction	14.0		1	
Exchange Branch	5832	Multi-Set Back	28.1		2	
Indoor Swimming Pool	5901	Piping Insulation	2.0	30		
Indoor Swimming Pool	5901	HW Temperature Reduction	14.0		1	
Indoor Swimming Pool	5901	Multi-Set Back	28.1		2	
Enlisted Men's Barracks	5910	Piping Insulation	2.0	20		
Admin/Storage	5917	Duct Insulation	1.0	4		
Admin/Storage	5917	Piping Insulation	2.0	12		
Admin/Storage	5917	HW Temperature Reduction	14.0		1	
Brigade Chapel	5950	Personnel Door Weatherstrip	7.0	12		
Exchange Branch	5956	Duct Insulation	1.0	14		
Exchange Branch	5956	Piping Insulation	2.0	14		
Exchange Branch	5956	Personnel Door Weatherstrip	7.0	8		
Exchange Branch	5956	HW Temperature Reduction	14.0		1	
DIO-CPO	6043	Piping Insulation	2.0	14		
DIO-CPO	6043	Personnel Door Weatherstrip	7.0	8		
DIO-CPO	6043	HW Temperature Reduction	14.0		1	
DIO-CPO	6043	Multi-Set Back	28.1		1	
Community Service Center	6049	Piping Insulation	2.0	15		
Community Service Center	6049	Revise Boiler Controls	49.0	1		
Red Cross	6051	HW Temperature Reduction	14.0		1	
Sports Arena	6053	HW Temperature Reduction	14.0		1	
Sports Arena	6053	Multi-Set Back	28.1		12	
Bowling Alley	6054	Piping Insulation	2.0	7		
Bowling Alley	6054	Personnel Door Weatherstrip	7.0	3		
Bowling Alley	6054	HW Temperature Reduction	14.0		1	
Bowling Alley	6054	Multi-Set Back	28.1		1	
Library	6501	Piping Insulation	2.0	30	8	
Library	6501	Multi-Set Back	28.1			

NARRATIVE

The command personnel at Fort Dix have had a continuing goal of reducing base energy costs and consumption without reduction of operational readiness or personal comfort. In the last five years the base has won $966,000 in awards for energy conservation (see table B-1). With the intent to find additional energy conservation opportunities, the firm of Einhorn Yaffee and Prescott was retained in October 1985 to perform an Energy Savings Opportunity study. Sixty three typical and representative buildings were selected for this study. Since the buildings are typical extrapolations of the results of this study can be applied to the base at large.

Table B-1

TRADOC Annual Energy Awards Presented to Fort Dix

1982	$ 50,000
1983	440,000
1984	269,000
1985	157,000
1986	50,000
5 year total	$ 966,000

Base Line Information

The establishment of current or baseline conditions is a prerequisite to any comparative study. The energy consumption of the entire base was readily available and is presented in Tables B1, B2, B3 and B4. Data for individual buildings is not available since separate metering is against Army regulations. As a result, it was necessary to model existing conditions on a computer and estimate base line energy use. Electrical consumption is estimated by total connected load, the sum of the energy draw when all lights and equipment are in use. Heating loads are based on building construction and their resistance to heat flow. In it's simplest form building heat losses can be calculated by the Equation:

$$Q = U \times A \times \Delta T$$

Where Q is the heat loss in BTU/hr, U is the heat conductance in BTU per sq.ft. per degree fahrenheit, A is the surface area of the walls or roof in square feet and ΔT is temperature difference between inside and outside air in degrees fahrenheit.

Seasonal energy use may be estimated through a modification of the above formula to account for the sum of the average indoor temperature and outdoor temperature taken on a daily basis. This is known as the Degree Day Formula and is given by:

$$E = U \times A \times D \times 24 \text{ hr/day} \times CD$$

Where E is the total energy used in BTU, D is the number of local degree days and CD is an emprical correction factor.

In section C of this report each building is given two reference numbers. The first, the Total Building Load Factor is the sum of all the component UA's for the building and may be used directly in the degree day formula (Table B-5). The second or Design Energy Use Index is in essence the product of U (Tinside - Toutside) under extreme (design weather) conditions. For the Fort Dix Area Toutside is assumed to be -1 degree fahrenheit. These reference values may be used to compare the relative effectiveness of the buildings to retain their heat. The Design Energy Use Index for each building surveyed is given in the bar graph of Table B-6.

Method of Analysis

In December of 1985 and January of 1986 the A/E sent a field team to Fort Dix to conduct an audit of the selected sixty-three buildings. As the team inspected each building, notes were taken on the existing conditions, building construction, electrical requirements and mechanical equipment. For each building a checklist of possible energy saving opportunities (ECOs) was maintained, and field notes pertinent to those ECO's deemed applicable to the building were taken. The results of the field audit were then taken back to the A/E's office for further analysis. Data based on field observation was fed into the computer to generate the base line information for each building as described above. For each ECO found applicable by the field team estimates of installation and maintenance costs were developed using standard and accepted methodologies. These methods included standard estimating references such as Means Cost Data, vendor quotes and recent experiences of the A/E.

Energy savings were calculated for each ECO using one of two methods. In a few cases a straight forward hand calculation was possible based on percent reduction of consumption or use. For most ECO's a more complex bin calculation was done by the computer. In these calculations reductions were considered on a monthly and hourly basis. The supporting savings calculations are contained in volumes 4 and 5 of this report. The calculations are organized numerically by building and then ECO.

The next step was to determine the economic feasibility of the ECO using Energy Conservation Improvement Program (ECIP) guidelines. To accomplish this the computer performed a life cycle cost analysis with the cost estimates and savings data previously determined. The summary sheet for this analysis can be found for each ECO in section C of the

report. An ECO was determined economically feasible if total life dollar savings divided by total costs was greater than 1. This ratio is referred to as the SIR or Savings Investment Ratio. The recommended ECO's are organized in the body of the report in two ways. First, each ECO analyzed for a given building is reviewed in section C. A summary of these analyses is found on the page following the base line data for each building. The ECO's are listed in order of highest to lowest SIR value. Second, section D gives a brief narrative description of each ECO type. Following the description is a table listing the savings summary of that ECO for each building where it was deemed applicable.

Recommended Projects

At the request of the Fort Dix, DEH individual Programming Documentation (Form DD1391) has been prepared for each recommended ECO category. Often the magnitude of investment does warrant an ECO to be treated as a separate project. Smaller cost ECOs have been grouped into packages of two or more involving similar work and a composite DD1391 prepared.

These projects can be funded through a number of sources depending on their investment costs and SIR values.

If all of the proposed ECOs are implemented an estimated 229,000 million BTU in electric and fuel bills can be saved annually as shown on Table B-7.

FORT DIX

HISTORICAL ENERGY USE

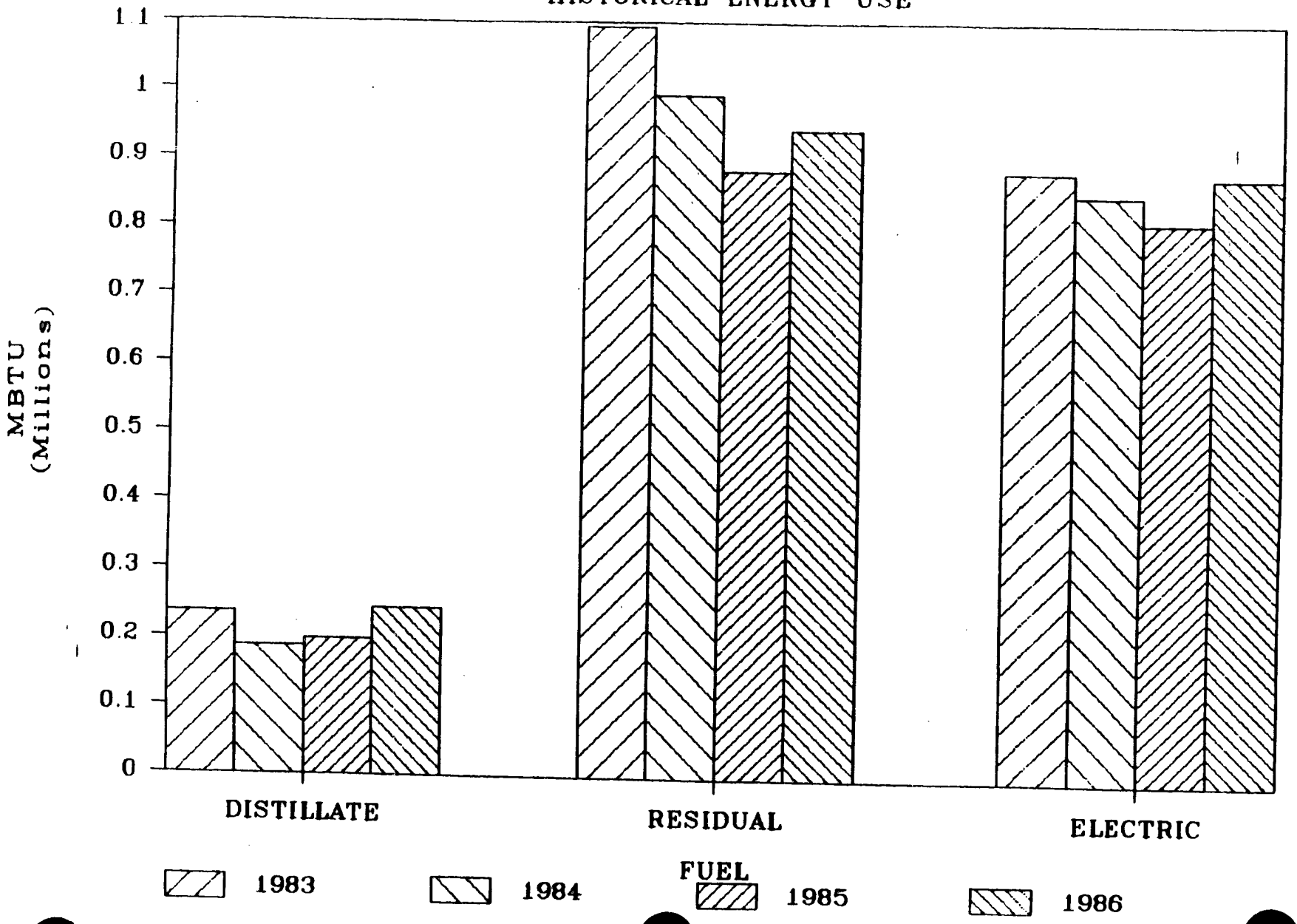


TABLE B-2

FORT DIX

PRESENT ENERGY USE

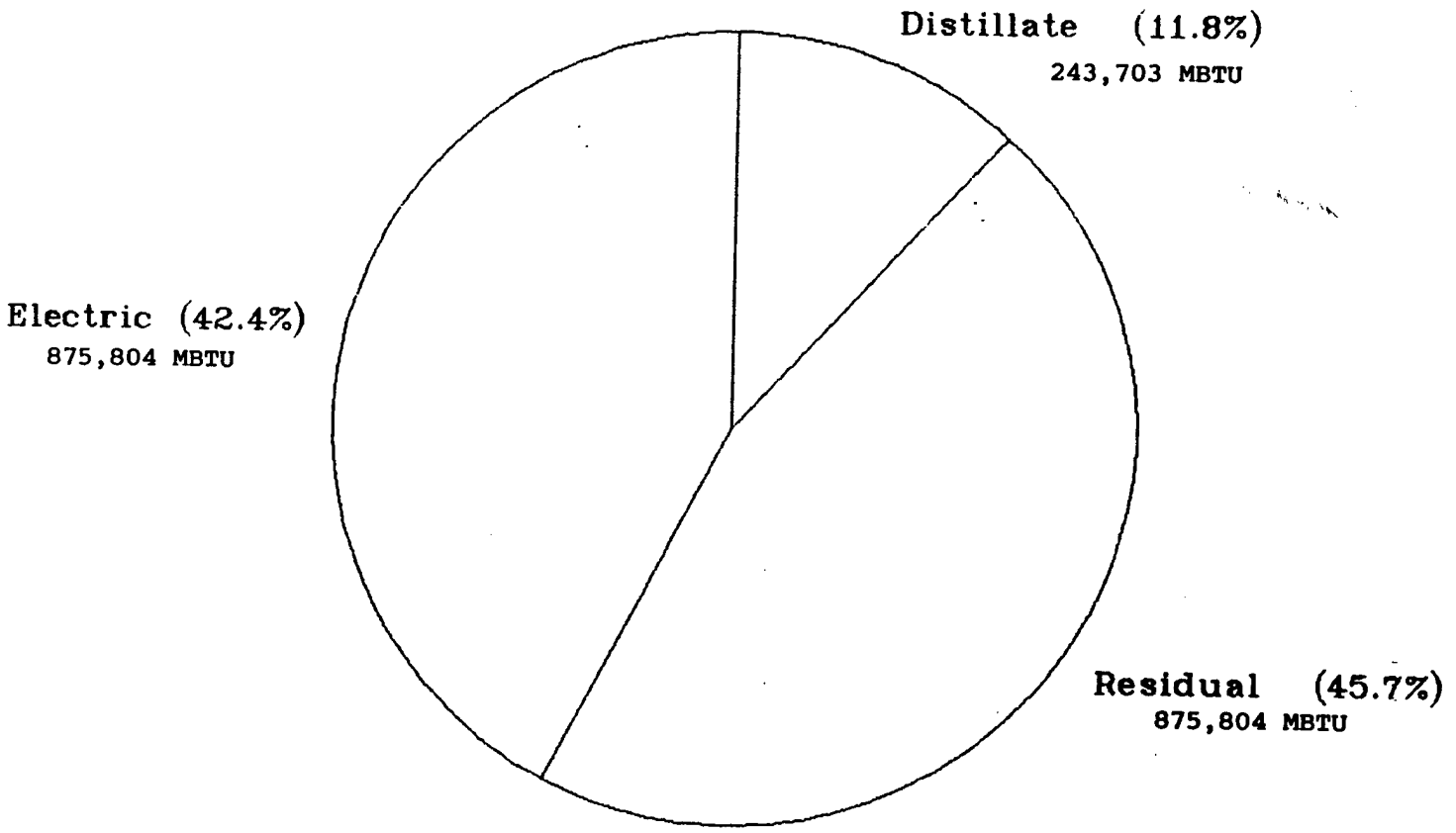


TABLE B-3

FORT DIX

PRESENT ENERGY COST

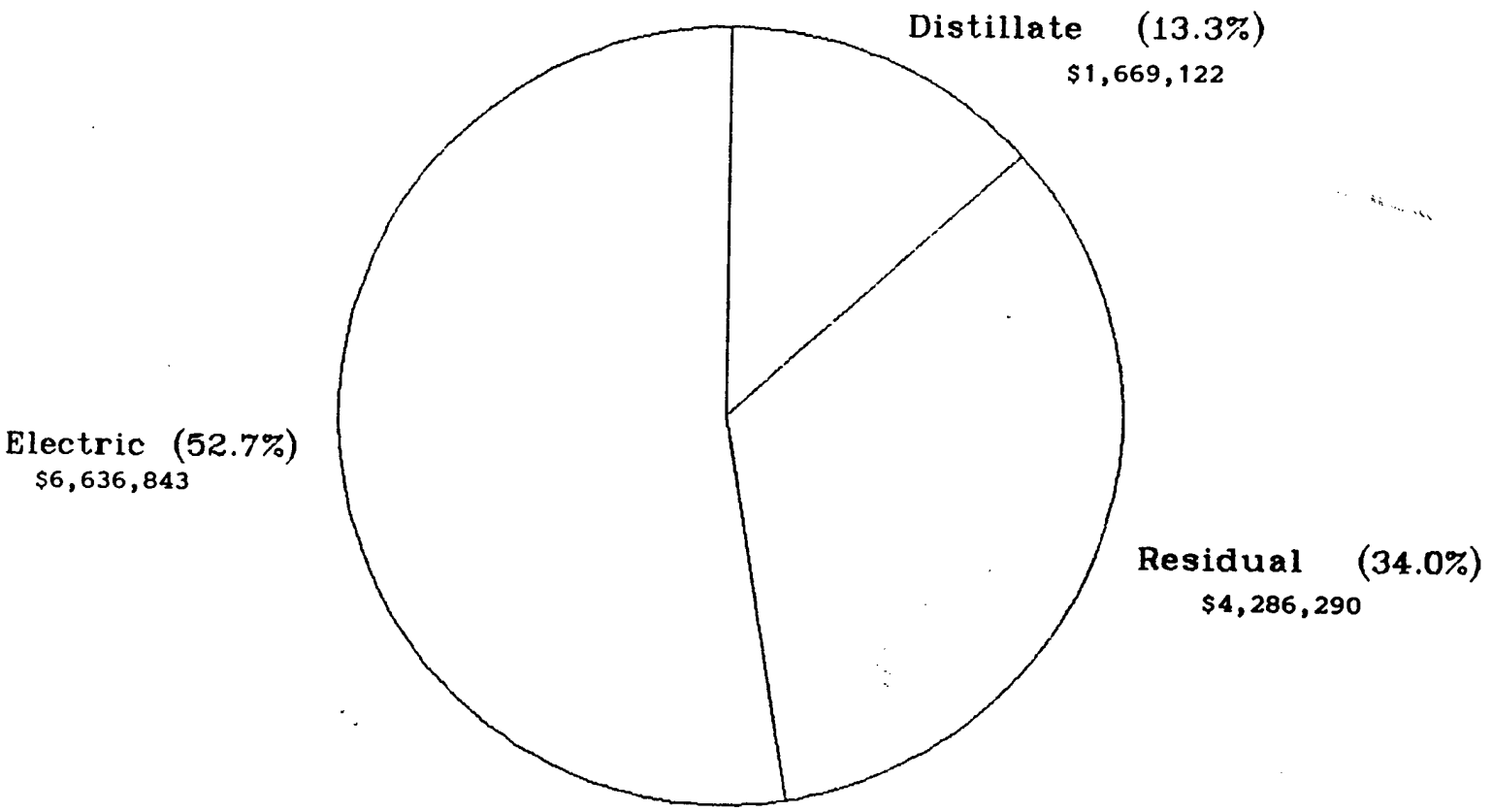


TABLE B-4

FORT DIX

BUILDING LOAD FACTOR - BTUH/DEG

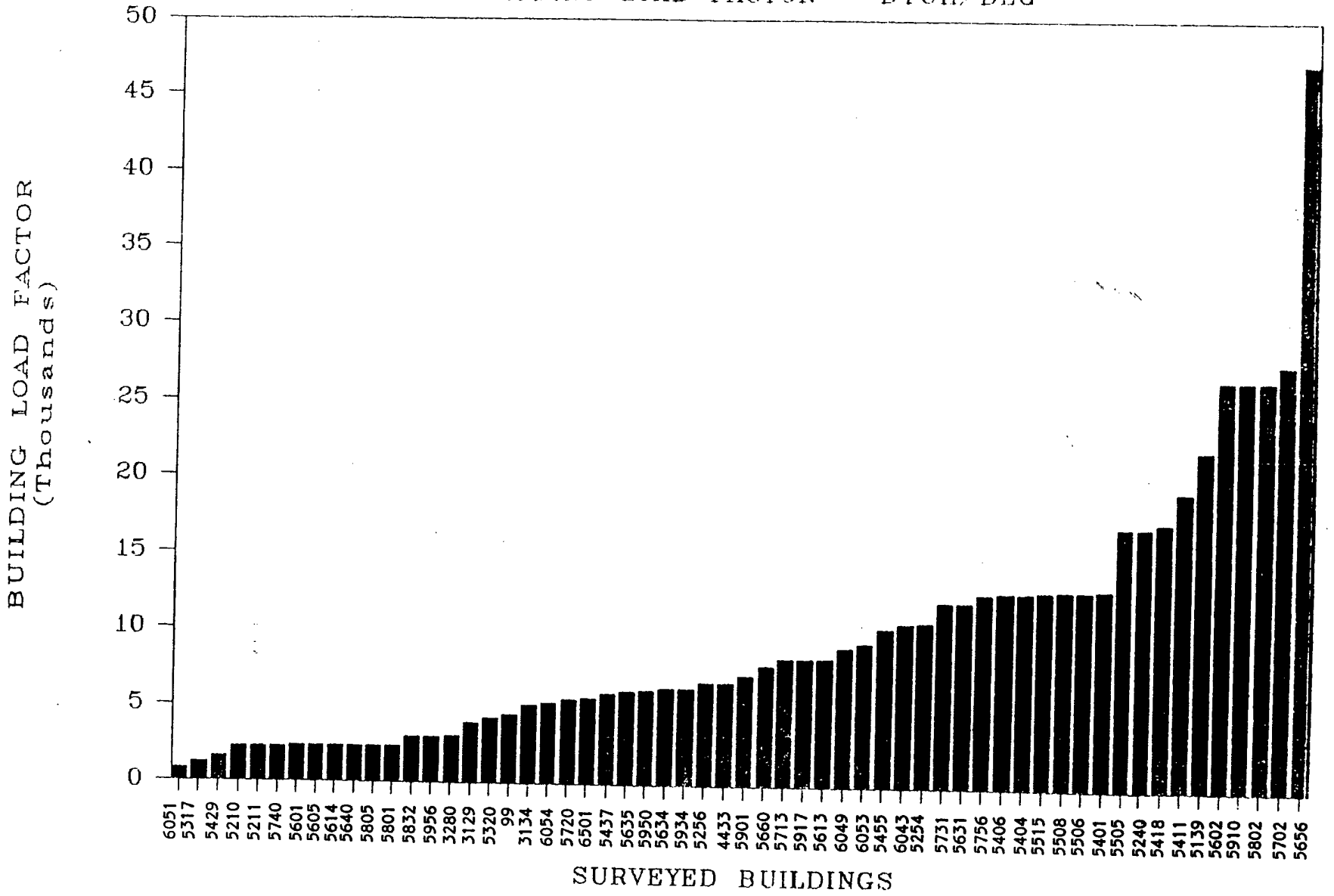


TABLE B-5

FORT DIX

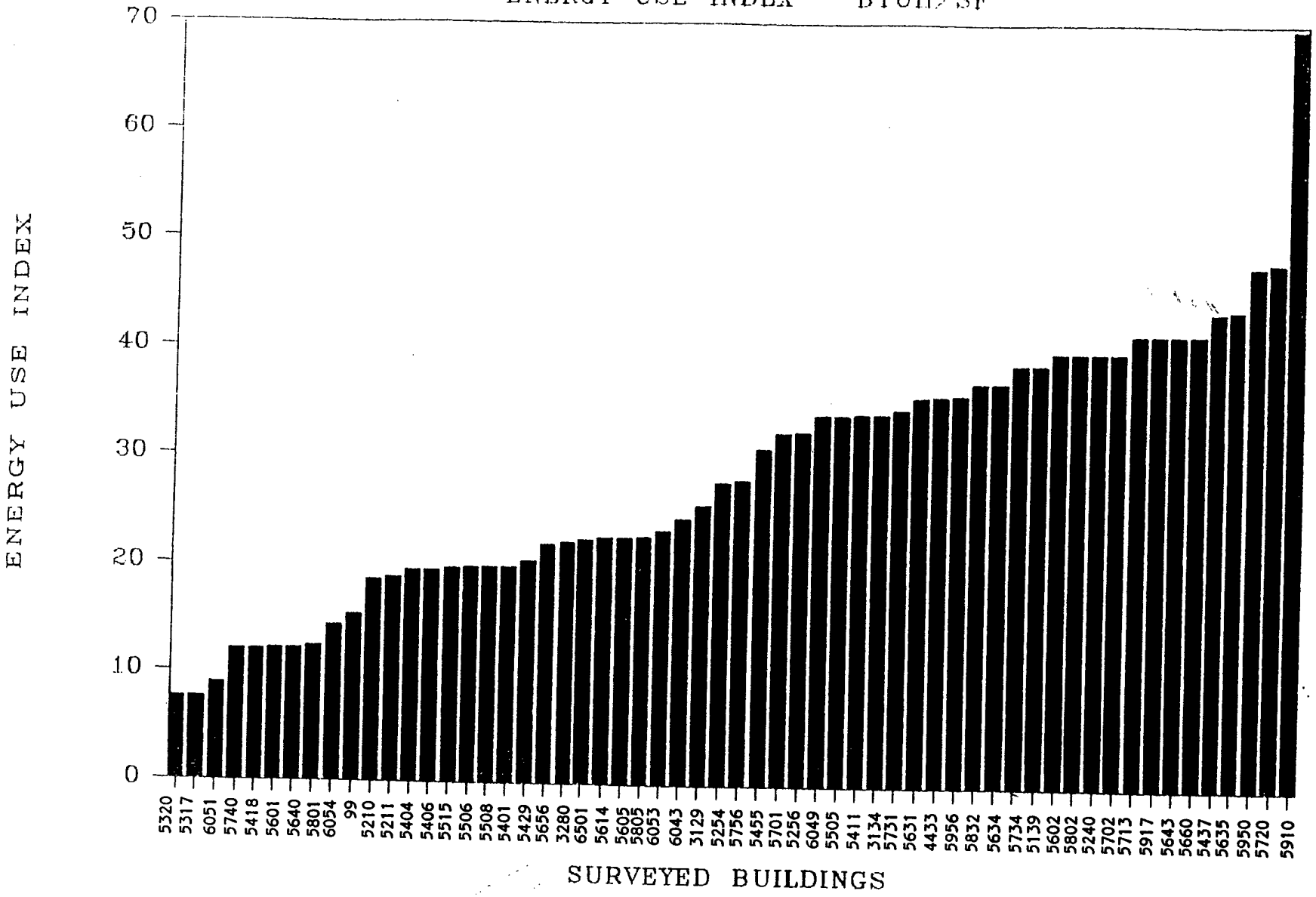


TABLE B-6

ANNUAL SAVINGS VS INITIAL COST

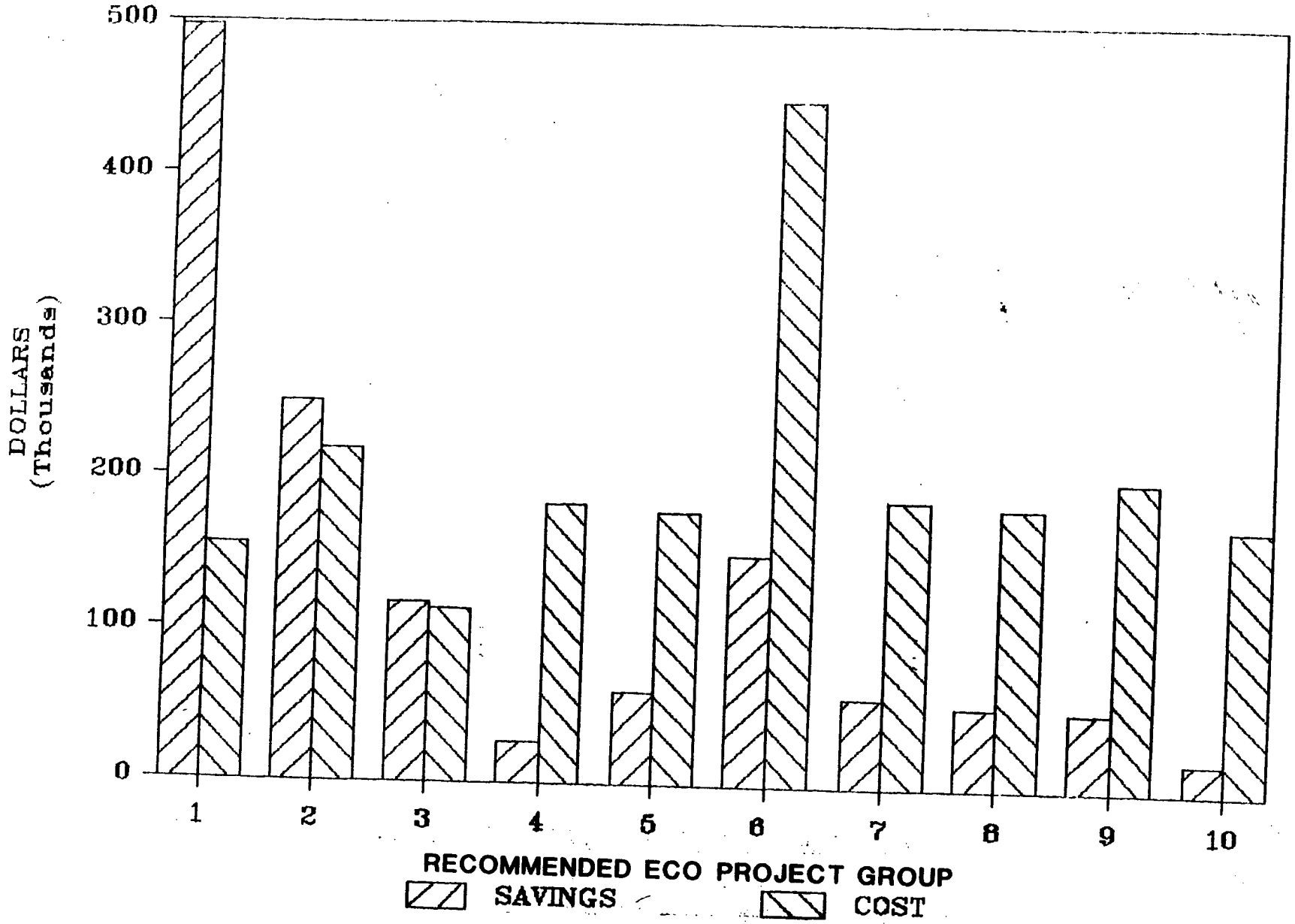
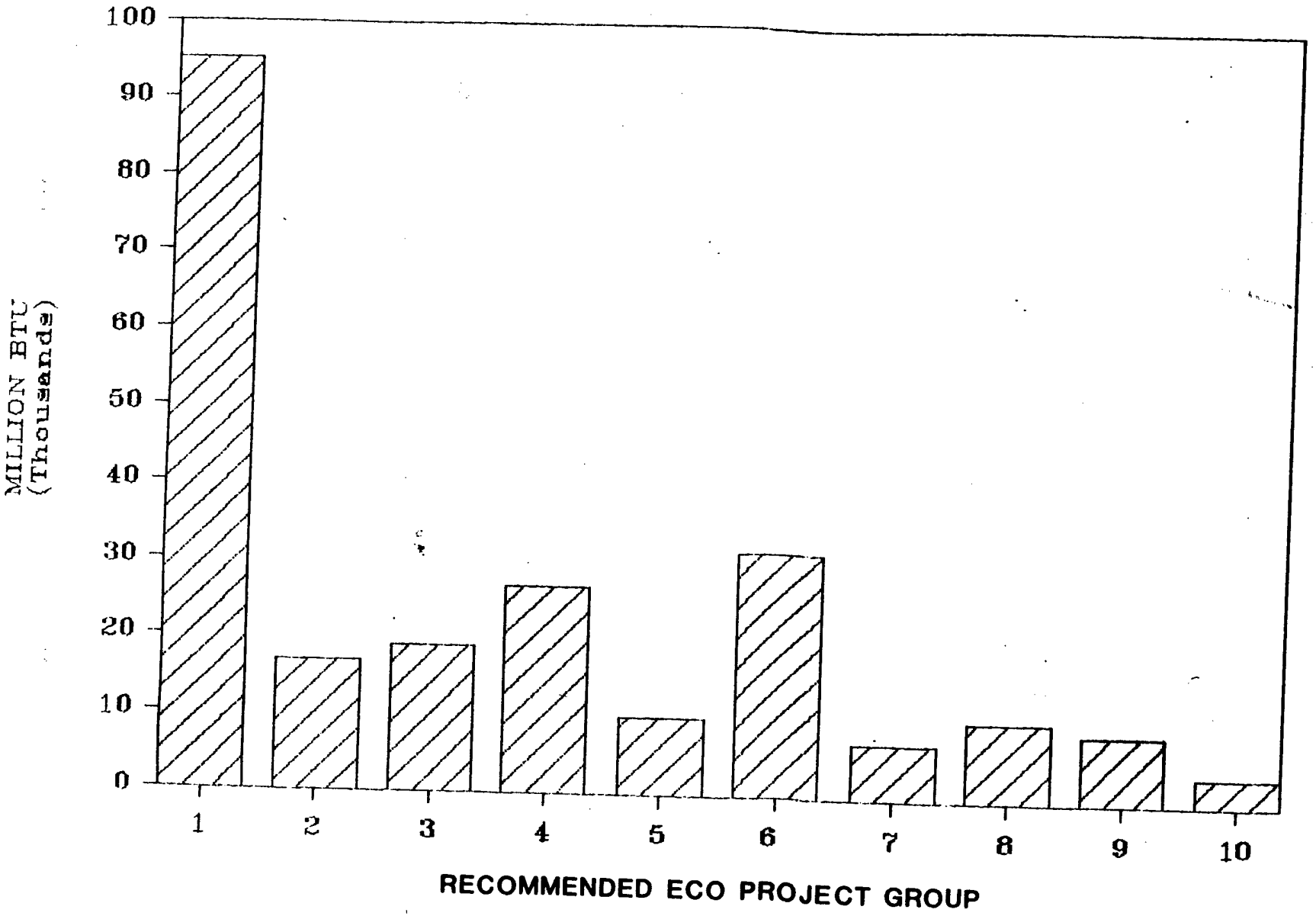


TABLE B

TOTAL ENERGY SAVINGS



TABLE

As a result of the Energy Savings Opportunity Study described on the previous pages. The recommended ECO's have been grouped into ten proposed projects. These projects can be used to form the basis of a long-term energy conservation plan for Fort Dix to be administered by the Directorate of Energy and Housing (DEH). The ECO groups are found on Table C-1 and show the economic justifications.

TABLE C-1

ECO PROJECT GROUPING

Group	ECO's Included		Initial Cost	Annual Mega-BTU	Savings Dollars	SIR	SPB	Project Classificatic
1	#14	HW Temp. Reduction,*	153,696	95,175	497,000	36.8	0.3	OSD-PIF
	#16	Flow Restrictors,						
	#21	Air Volume Reduction,*						
	#22	Outside Air Reduction,*						
	#28	Temperature control/ setback,						
	#39	Lighting Level Reduction *						
	#48	Install Time Clocks						
2	#41	Replace Lamps/Ballasts	218,810	16,915	249,783	13.9	.90	ECIP
3	#1	Duct Insulation *	113,498	18,862	118,336	13.9	1.0	OSD-PIF
	#17	CV to VAV						
	#23	Zone Control						
	#49	Revise Boiler Control *						
4	#2	Piping Insulation*	183,287	26,764	126,579	12.3	1.4	OSD-PIF
5	#27	Infrared Heat	178,284	9,986	60,350	3.61	3.0	OSD-PIF
	#29	Decentralized DHW						
	#31	Lighting Controls						
	#40	High Efficiency Motors						
	#51	Return Condensate*						
	#52	DHW Heat Pumps						
6a* *	#45	Radiator Controls	122,124	10,697	55,185	5.16	2.2	OSD-PIF
6b* *	#45	Radiator Controls	173,125	12,542	56,966	3.76	3.0	OSD-PIF
6c* *	#45	Radiator Controls	153,636	8,365	38,060	2.97	4.0	OSD-PIF
7	#37	Replace Light Fixtures	142,728	6,867	54,913	4.25	2.5	OSD- PIF
8	#24	Heat Recovery	183,006	10,150	53,454	3.47	3.4	OSD-PIF
	#25	Variable Speed Kitchenhood						
	#43	Control HW Circulation Pump						
	#47	Destratification						

* Maintenance ECO

** ECO#6 was split into 3 parts to maintain the $200,000 ceiling cost

Group	ECO's Included	Initial Cost	Annual Mega-BTU	Savings Dollars	SIR	SPB	Project Classification
9	#12 Ceiling Insulation	201,363	8,708	50,487	4.52	4.0	ECIP
10	#7 Personal Door Weather-Stripping #10 Inside Insulation Reduce Glass Area #46 Reduce Infiltration *	172,410	3,731	19.819	1.62	8.7	Other

The ECOs were placed in the groups based on three factors dictated by the Fort Dix DEH.

- Maintain overall costs per project less than $200,000 to be eligible for the more immediate non-ECIP funding programs such as OSD-PIF.
- Group high savings to investment ratio (SIR)/low simple payback (SPB) ECOs together.
- Attempt to group like ECOs together such that a single contract can be awarded for the entire project.

As these factors were not always mutually compatible, the A/E has had to use his discretion in the final groupings.

If all of the projects are fully implemented, Fort Dix can expect to save 229,000 million BTU annually saving 1,042,000 energy dollars. This is opposed to a total cost of implementation of $2,042,000 and a simple payback of 2 years.

The following pages contain a summary of each ECO project group and the savings which can be realized by the individual ECO. It should be noted that several of the project groups contain a mixture of maintenance and capital improvement ECO's. In the funding requests (form DD 1391) of the programming documents the maintenance implementation costs and resultant savings have been broken out such that this portion of the project can receive funding from operations and maintenance sources. These maintenance ECOs are noted on the summaries by the asterik.

The following pages contain a number of tabular summaries for the ten recommended Energy Conservation Projects. The first summary in each sub section is a composite of savings and investment costs for the recommended Energy Conservation project. This summary is followed by a more detailed building by building savings for each ECO within the project. The projects generally appear in order of the most cost effective first and least cost effective last.

The Fort Dix Directorate of Energy and Housing may use this data and the companion form DD1391's found in the programming documents to form a long term energy plan.

It should be noted that in several projects there are operations and maintenance ECOs included with capital improvement ECOs. The costs and savings for these have been broken out in the DD1391's so that funding can be obtained from appropriate sources. A summary table has been placed in the beginning of section D. For additional clarification the maintenance ECOs have been separately identified in the individual project summaries.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

OPERATION AND MAINTENANCE ITEMS

SUMMARY TABLE

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Duct Insulation	1	4,041.7	$21,111	$39,141	1.9	8.93
Piping Insulation	2	26,764.0	$126,579	$183,287	1.4	12.33
Personnel Door Weatherstrip	7	1,415.5	$6,806	$36,950	5.4	1.75
HW Temp Reduction	14	4,403.4	$21,021	$2,484	0.1	99.45
Air Volume Reduction	21	251.1	$1,184	$1,330	1.1	10.48
Outside Air Reduction	22	27,294.0	$127,953	$34,707	0.3	41.28
Multi-Set Back	28A	20,271.5	$124,047	$18,960	0.2	78.60
Reduce Lighting Levels	39	732.2	$5,907	$4,391	0.7	27.15
Reduce Infiltration	46	928.7	$4,267	$42,410	9.9	1.31
Revise Boiler Controls	49	1,008.8	$6,906	$17,960	2.6	4.62
Return Condensate	51	5,280.9	$24,095	$28,278	1.2	10.21
		92,391.8	$469,877	$409,898	0.9	15.62

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

GROUP 1

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Flow Restrictors	16	16,858.5	$80,204	$63,356	0.8	14.78
Multi-Set Back	28B	10,064.9	$52,068	$16,039	0.3	36.97
Install Time Clocks	48	15,299.6	$84,658	$14,434	0.2	62.72
		42,223.0	$216,930	$93,829	0.4	25.95

OPERATION AND MAINTENANCE ITEMS

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
HW Temp Reduction	14	4,403.4	$21,021	$2,484	0.1	99.45
Air Volume Reduction	21	251.1	$1,184	$1,330	1.1	10.48
Outside Air Reduction	22	27,294.0	$127,953	$34,707	0.3	41.28
Multi-Set Back	28A	20,271.5	$124,047	$18,960	0.2	78.60
Reduce Lighting Levels	39	732.2	$5,907	$4,391	0.7	27.15
		52,952.2	280,112.1	61,871.8	0.2	53.39
TOTAL		**95,175.2**	**$497,042**	**$155,701**	0.3	36.85

14 LOWER DOMESTIC HOT WATER TEMPERATURE

Typical domestic hot water temperature in most of the facilities surveyed ranged from 120°F to 140°F. Recommended values are 110°F for showers and 105°F for handwashing. In the facilities where domestic water is generated by steam-water heat exchangers, we recommend resetting or providing changing controllers or control valves. Some facilities use domestic hot water storage tanks with immersion aquastats to control setpoint. In these facilities it was recommended that the temperature be reset by either adjusting or changing the controlling aquastat.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #14 - HW TEMPERATURE REDUCTION

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Enlisted Men's Barracks	5702	214.6	$975	$20	15	11	2,360.8	$10,723	$221	.0	582.36
Exchange Branch	5956	30.8	$211	$20	15	2	61.6	$422	$40	0.1	152.75
Exchange Branch	5832	30.8	$211	$20	15	2	61.6	$422	$40	0.1	152.75
Enl. Men Barracks	5506	50.9	$231	$20	15	5	254.5	$1,155	$100	0.1	127.75
Indoor Swimming Pool	5901	29.6	$203	$20	15	1	29.6	$203	$20	0.1	121.42
Enlisted Men's Barracks	5406	87.6	$398	$40	15	4	350.3	$1,591	$160	0.1	118.80
Enlisted Men's Barracks	5404	87.6	$398	$40	15	4	350.3	$1,591	$160	0.1	118.80
BOQ	5254	96.6	$439	$60	15	2	193.2	$878	$120	0.1	80.81
Nurse's Quarters	5256	30.0	$136	$20	15	3	90.0	$408	$60	0.1	75.29
Bowling Alley	6054	19.6	$149	$20	15	1	19.6	$149	$20	0.1	71.93
Enlisted Men's Barracks	5401	50.1	$228	$40	15	4	200.4	$912	$160	0.2	62.87
Enlisted Men's Barracks	5602	18.6	$84	$20	15	11	204.6	$929	$221	0.2	50.47
Sports Arena	6053	11.4	$86	$20	15	1	11.4	$86	$20	0.2	41.84
Dental Clinic	5437	9.7	$74	$20	15	1	9.7	$74	$20	0.3	35.60
Provost Marshall	5210	9.3	$70	$20	15	4	37.2	$280	$80	0.3	34.13
Enl Men Ser Club	5756	8.7	$66	$20	15	1	8.7	$66	$20	0.3	31.93
Red Cross	6051	8.2	$62	$20	15	1	8.2	$62	$20	0.3	30.09
DIO-CPO	6043	8.1	$61	$20	15	1	8.1	$61	$20	0.3	29.73
Reception Center	5656	8.6	$39	$20	15	1	8.6	$39	$20	0.5	21.58
DIO Administration	5418	27.9	$211	$120	15	1	27.9	$211	$120	0.6	17.07
NCO Open Mess	5455	6.1	$28	$20	15	1	6.1	$28	$20	0.7	15.31
Brigade Gym	5631	5.4	$24	$20	15	2	10.7	$49	$40	0.8	14.56
Dispensary	5429	3.9	$29	$20	15	6	23.2	$176	$120	0.7	14.22
Admin/Storage	5917	3.5	$26	$20	15	5	17.4	$132	$100	0.8	12.80
Brigade Classroom	5411	2.9	$22	$20	15	1	2.9	$22	$20	0.9	10.66
DEH Admin Bldg	5320	8.2	$62	$60	15	1	8.2	$62	$60	1.0	10.03
Motor Repair Shop	5720	2.3	$18	$20	15	6	14.0	$106	$120	1.1	8.53
Supply Serv. Admin	5211	1.5	$11	$20	15	5	7.5	$55	$100	1.8	5.51
Battalion Headquarters	5614	1.4	$10	$20	15	5	6.8	$52	$100	1.9	4.99
Battalion Headquarters	5605	1.4	$10	$20	15	5	6.8	$52	$100	1.9	4.99
Transport Div	5139	3.5	$27	$60	15	1	3.5	$27	$60	2.3	4.28
Total							4,403.4	$21,021	$2,686	0.1	99.45

FLOW RESTRICTORS

Most of the buildings have shower rooms, men's and women's toilet rooms. The shower heads and the lavatory faucets in these rooms are not equipped with special devices which reduce water flow without changing the temperature of the water. Energy and water savings can be realized if flow restrictors are used. These devices not only save water and the energy required to heat it, but deliver sufficient quantities to shower heads and lavatory faucets.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #16 - FLOW RESTRICTORS

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Enlisted Men's Barracks	5702	701.1	$3,184	$842	15	11	7,712.0	$35,028	$9,267	0.3	45.29
Enl. Mens Barracks	5515	147.9	$1,121	$264	15	5	739.5	$5,605	$1,320	0.1	41.28
Motor Repair Shop	5720	27.0	$204	$53	15	6	161.8	$1,226	$319	0.3	37.34
DEH Admin Bldg	5320	16.10	$122	$53	15	1	16.1	$122	$53	0.40	22.30
Indoor Swimming Pool	5901	65.2	$447	$281	15	1	65.2	$447	$281	0.6	19.09
Enlisted Men's Barracks	5802	486.5	$2,210	$1,601	15	11	5,351.2	$24,305	$17,611	0.7	16.55
DIO Administration	5418	63.2	$479	$351	15	1	63.2	$479	$351	0.7	13.25
Brigade Gym	5631	39.2	$178	$211	15	2	78.3	$356	$421	1.2	10.12
Brigade Headquarters	5634	15.8	$120	$123	15	2	31.5	$239	$247	1.0	9.41
Enl. Men Barracks	5506	58.8	$267	$316	15	5	294.0	$1,335	$1,580	1.2	9.37
BOQ	5254	96.4	$429	$527	15	2	188.8	$858	$1,054	1.2	9.03
Battalion Headquarters	5614	7.9	$60	$70	15	5	39.4	$299	$351	1.2	8.27
Nurse's Quarters	5256	44.6	$203	$281	15	3	133.8	$609	$843	1.4	8.00
Battalion Headquarters	5605	7.2	$55	$70	15	5	36.0	$273	$351	1.3	7.56
Enl. Men Barracks	5508	41.5	$188	$316	15	5	207.5	$940	$1,580	1.7	6.61
Battalion Headquarters	5734	10.3	$78	$123	15	3	30.8	$233	$370	1.6	6.13
Brigade Classroom	5611	16.9	$128	$211	15	1	16.9	$128	$211	1.6	5.89
Enlisted Men's Barracks	5601	128.9	$585	$1,124	15	4	515.6	$2,340	$4,496	1.9	5.78
Brigade/Classroom	5505	12.3	$93	$211	15	1	12.3	$93	$211	2.3	4.31
Enlisted Men's Barracks	5406	86.5	$393	$1,229	15	4	346.0	$1,571	$4,915	3.1	3.83
Enlisted Men's Barracks	5404	86.5	$393	$1,229	15	4	346.0	$1,571	$4,915	3.1	3.83
Enlisted Men's Barracks	5602	41.9	$190	$1,106	15	11	460.4	$2,091	$12,169	5.8	2.06
Admin/Storage	5643	2.4	$11	$88	15	5	12.2	$55	$441	8.0	1.50
Total							16,858.5	$80,204	$63,356	0.8	14.78

21 AIR VOLUME REDUCTION

The existing air conditioning units were originally provided with access doors. Presently some access doors are missing. As a result, an uncontrollable volume of air is entering the units, bypassing the heating and cooling coils. The temperature control sensors modulate control valves on coils to operate with much lower temperature differences, thus decreasing the efficiency of the equipment. It is recommended that these openings be closed and sealed as required.

Expected savings:

Reduction on fan motor consumption.
Reduction on steam and chilled water consumption.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #21 - AIR VOLUME REDUCTION

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Battalion Headquarters	5805	41.9	$197	$222	15	6	251.1	$1,184	$1,330	1.1	10.68
Total							251.1	$1,184	$1,330	1.1	10.68

22 OUTSIDE AIR REDUCTION

All air handling and air conditioning units are equipped with the outside and the return air dampers. The outside and return air dampers are balanced and controlled to maintain outside air volume in the building. The outside air entering the system in excess of what is required or necessary contributes to the waste of energy. Reducing the amount of outside air to the minimum consistent with the building pressurization and code requirements can reduce the amount of heating and cooling. This reduction can be used on any system which provides fresh air to the building. The amount of outside air can be reduced to the minimum allowed by state or local code through:

A. Assure that outside air dampers are in good operating condition
B. Adjustment of the damper linkages
C. Adjustment of the minimum positioning switches.

Leaking air dampers contribute to the waste of thermal energy considerably. It is a good engineering practice to utilize low leakage outside air dampers.

Expected savings:

Outside air reduction
Reduction of steam consumption
Reduction of chilled water consumption

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #22 - OUTSIDE AIR REDUCTION

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Reception Center	5656	14,070.3	$63,907	$3,026	15	1	14,070.3	$63,907	$3,026	0.1	234.25
Enl Men Ser Club	5756	3,105.6	$15,939	$2,015	15	1	3,105.6	$15,939	$2,015	0.1	84.61
Battalion Headquarters	5734	337.8	$1,534	$264	15	3	1,013.4	$4,603	$791	0.2	69.70
Battalion Headquarters	5614	743.4	$3,499	$878	15	5	3,717.1	$17,495	$4,388	0.3	46.99
Brigade Chapel	5635	216.8	$1,117	$301	15	2	433.6	$2,234	$602	0.3	42.00
Brigade Headquarters	5634	185.9	$972	$301	15	2	371.8	$1,944	$602	0.3	36.32
Enlisted Men's Mess Hall	5760	729.8	$3,485	$1,052	15	4	2,919.2	$13,939	$4,208	0.3	36.19
Brigade Gym	5731	199.5	$906	$673	15	2	398.9	$1,812	$1,346	0.7	16.13
Brigade Chapel	5950	36.2	$183	$149	15	2	72.4	$366	$299	0.8	13.96
Exchange Branch	5832	97.9	$467	$503	15	2	195.9	$934	$1,007	1.1	10.86
Brigade Gym	5631	166.8	$758	$878	15	2	333.7	$1,515	$1,755	1.2	10.35
Indoor Swimming Pool	5901	63.8	$437	$1,018	15	1	63.8	$437	$1,018	2.3	5.15
Exchange Branch	5956	97.9	$467	$1,806	15	2	195.8	$933	$3,612	3.9	2.82
Enlisted Men's Mess Hall	5601	67.3	$318	$1,458	15	4	269.3	$1,270	$5,833	4.6	2.56
Enlisted Men's Mess Hall	5801	33.3	$156	$1,051	15	4	133.1	$623	$4,204	6.7	1.75
Total							27,294.0	$127,953	$34,707	0.3	41.28

28. Temperature Control/Setback

This ECO has two major components designed to bring space temperatures into line with DOD guidelines during occupied hours and provide for additional savings through automatic temperature setback during unoccupied hours.

The two components of this ECO are:

- Maintenance repair and or replacement of damaged thermostats, a large number of which were observed to be non-functional.

- Upgrading of currently existing thermostats from conventional manual models to seven day programmable versions which would allow space temperatures to drop from 68° during occupied hours to 55 during periods of inactivity.

In many cases manual thermostats which are currently damaged should be replaced with programmable units. In these cases the funding will come from a combination of sources, operations and maintenance as well as capital improvement.

At the time of this study a contract had been issued for development of an Energy Monitoring and Control System (EMCS). This ESOS has recommended individually controlled programmable thermostats. These thermostats are less expensive than adding control and monitoring points to the central EMCS. The more flexible control available from the EMCS is not cost effective relative to the increased premium. Possible non-energy benefits of an EMCS are beyond the scope of this contract.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #28A - MULTI-SETBACK

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
General Purpose Warehouse	3134	507.5	$3,476	$120	15	13	6,597.7	$45,188	$1,565	.0	346.67
Bowling Alley	6054	255.6	$1,820	$92	15	1	255.6	$1,820	$92	0.1	218.83
Transport Div	5139	822.8	$5,635	$335	15	1	822.8	$5,635	$335	0.1	201.93
DIO-CPO	6043	349.4	$2,426	$185	15	1	349.4	$2,426	$185	0.1	153.56
Enl. Mens Barracks	5515	648.9	$2,947	$226	15	5	3,244.5	$14,735	$1,130	0.1	144.76
Indoor Swimming Pool	5901	386.4	$2,646	$277	15	1	386.4	$2,646	$277	0.1	114.76
Hangar	4433	668.4	$4,578	$677	15	5	3,341.9	$22,889	$3,385	0.2	81.17
General Purpose Warehouse	3129	65.7	$450	$75	15	13	854.1	$5,850	$975	0.2	71.81
Dental Clinic	5437	340.5	$2,332	$1,006	15	1	340.5	$2,332	$1,006	0.2	62.02
Brigade Classroom	5411	862.6	$3,918	$903	15	1	862.6	$3,918	$903	0.2	48.11
DIO Administration	5418	490.6	$2,228	$602	15	1	490.6	$2,228	$602	0.3	41.04
Motor Repair Shop	5720	220.7	$1,002	$301	15	6	1,324.1	$6,014	$1,806	0.3	36.93
NCO Open Mess	5455	212.4	$965	$382	15	1	212.4	$965	$382	0.4	29.98
Library	6501	318.4	$2,181	$1,293	15	1	318.4	$2,181	$1,293	0.6	20.26
Exchange Branch	5832	103.7	$561	$307	15	2	207.4	$1,122	$614	0.5	19.27
Brigade/Classroom	5505	258.8	$1,175	$903	15	1	258.8	$1,175	$903	0.8	14.43
Enlisted Men's Barracks	5404	52.6	$399	$369	15	4	210.4	$1,596	$1,476	0.9	10.49
Sports Arena	6053	193.9	$1,328	$2,031	15	1	193.9	$1,328	$2,031	1.5	7.85
Total							20,271.5	$124,047	$18,960	0.2	78.60

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #28B - MULTI-SETBACK

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
DIO-CPO	6043	492.9	$3,409	$116	15	1	492.9	$3,409	$116	0.1	344.98
NCO Open Mess	5455	265.1	$1,204	$69	15	1	265.1	$1,204	$69	0.1	192.85
DEH Admin Bldg	5320	283.7	$1,943	$168	15	1	283.7	$1,943	$168	0.1	139.25
Indoor Swimming Pool	5901	238.7	$1,635	$175	15	1	238.7	$1,635	$175	0.1	112.45
Bowling Alley	6054	168.2	$1,152	$151	15	1	168.2	$1,152	$151	0.1	91.92
Enlisted Men's Barracks	5401	529.8	$2,406	$503	15	4	2,119.2	$9,624	$2,012	0.2	53.08
DIO Administration	5418	751.50	$3,413	$739	15	1	751.5	$3,413	$739	0.2	51.25
Exchange Branch	5832	128.7	$675	$145	15	2	257.4	$1,350	$290	0.2	49.66
BOQ	5254	330.2	$1,500	$335	15	2	660.4	$3,000	$670	0.2	49.62
Dental Clinic	5437	271.0	$1,856	$554	15	1	271.0	$1,856	$554	0.3	40.24
Brigade/Classroom	5505	686.7	$3,119	$1,108	15	1	686.7	$3,119	$1,108	0.4	31.22
Motor Repair Shop	5720	220.7	$1,002	$369	15	6	1,324.1	$6,014	$2,214	0.4	30.10
Enl. Mens Barracks	5515	152.5	$693	$277	15	5	762.5	$3,465	$1,385	0.4	27.73
Brigade Classroom	5411	576.6	$2,619	$1,108	15	1	576.6	$2,619	$1,108	0.4	26.22
Library	6501	258.2	$1,768	$815	15	1	258.2	$1,768	$815	0.5	26.06
Supply Serv. Admin	5211	146.6	$1,004	$503	15	5	733.0	$5,020	$2,515	0.5	23.99
DEH Supply/NYCE	5317	68.2	$467	$335	15	2	136.4	$934	$670	0.7	16.74
Sports Arena	6053	79.3	$543	$1,280	15	1	79.3	$543	$1,280	2.4	5.09
Total							10,064.9	$52,068	$16,039	0.3	36.97

39 REDUCE LIGHTING LEVELS

Whenever lighting levels exceed the levels as recommended by the Department of Defense, the lighting must be minimized to bring the levels down. Examples of illumination levels required are as follows:

Usage	Foot-candles
Office	50
Toilet	15
Conference	30
Corridor	15
Storage	10

Also, it is often possible to reduce lighting in non-critical areas such as walkways in office areas, while still maintaining required illumination at the work area. This method of task lighting provides varying degrees of lighting levels.

General area illumination reduction and task lighting require either delamping or relamping. Delamping implies removing entire fixtures (or bulbs/lamps from fixtures). Relamping reduces energy consumption of existing fixture (such as replacing 100 watt bulb with 60 watt bulb). Both methods are generally low cost operational and maintenance measures which can be implemented by in-house personnel.

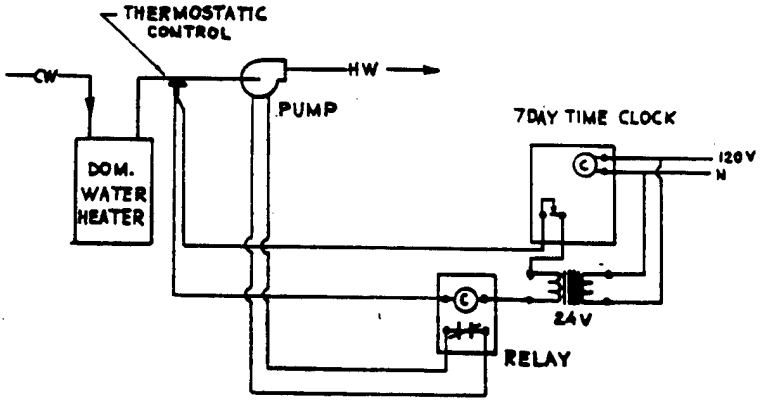
ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #39 - REDUCE LIGHTING LEVELS

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Dental Clinic	5437	33.7	$254	$120	25	1	33.7	$254	$120	0.3	40.21
Enlisted Men's Barracks	5404	34.7	$281	$160	25	4	138.8	$1,124	$642	0.3	39.81
Enlisted Men's Barracks	5406	34.7	$281	$160	25	4	138.8	$1,124	$642	0.3	39.81
DEH Admin Bldg	5320	27.3	$211	$120	25	1	27.3	$211	$120	0.4	33.06
Enlisted Men's Barracks	5401	24.8	$201	$120	25	4	99.2	$804	$480	0.4	32.76
Enl Men Ser Club	5756	16.9	$137	$80	25	1	16.9	$137	$80	0.4	30.77
Main Chapel	5240	8.2	$66	$48	25	1	8.2	$66	$40	0.4	27.67
BOQ	5254	9.1	$74	$40	25	2	18.2	$148	$80	0.4	27.30
Battalion Headquarters	5734	9.6	$88	$60	25	3	28.8	$265	$181	0.4	26.85
Battalion Headquarters	5614	19.7	$158	$120	25	5	98.4	$789	$602	0.5	24.43
Transport Div	5139	37.1	$287	$321	25	1	37.1	$287	$321	0.7	17.41
DIO Administration	5418	71.9	$584	$642	25	1	71.9	$584	$642	0.7	16.27
Transport Div	5139	14.8	$114	$442	25	1	14.8	$114	$442	2.3	5.11
Total							732.2	$5,907	$4,391	0.7	27.15

48 INSTALLATION OF TIME CLOCK AND THERMOSTATIC CONTROL FOR DHW CIRCULATION PUMP

Domestic hot water for most of the buildings is provided by steam or electrical hot water heaters equipped with hot water circulation pumps. A large portion of these buildings do not have devices for automatically shutting off the hot water circulation pumps during night time or unoccupied hours. We recommend providing a time clock and a thermostatic control for the domestic hot water pump. The thermostatic device cuts out the pump when water temperature reaches 130°F and cuts back in when the temperature drops to 105°F.



Savings: Reduction on electrical consumption on the make-up domestic hot water.

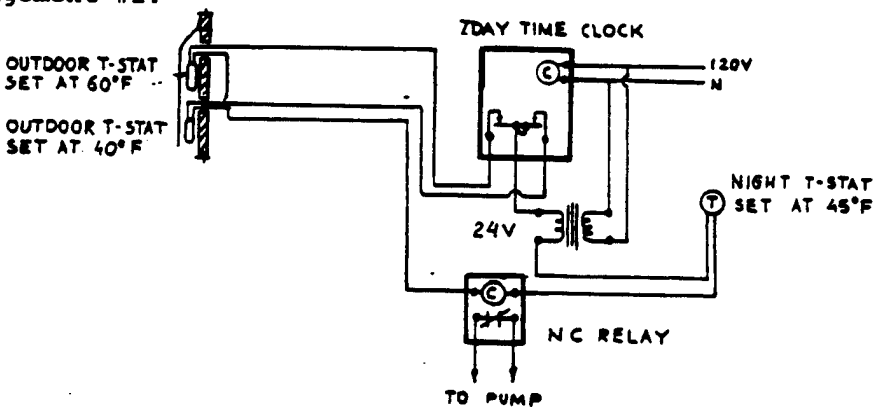
48B INSTALLATION OF TIME CLOCK WITH OUTDOOR AIR SENSOR

Most of the facilities do not provide automatically shutting off heating and cooling devices during unoccupied hours. A large portion of the 63 facilities do not have day/night thermostats which provide setback or setup space temperature based on time of day. Although some of the facilities use outdoor thermostats to shutoff hot water circulation pumps above 60°F outside air temperature, none have the capability of resetting the shutoff setpoint during unoccupied hours.

We recommend providing three time clock arrangements:

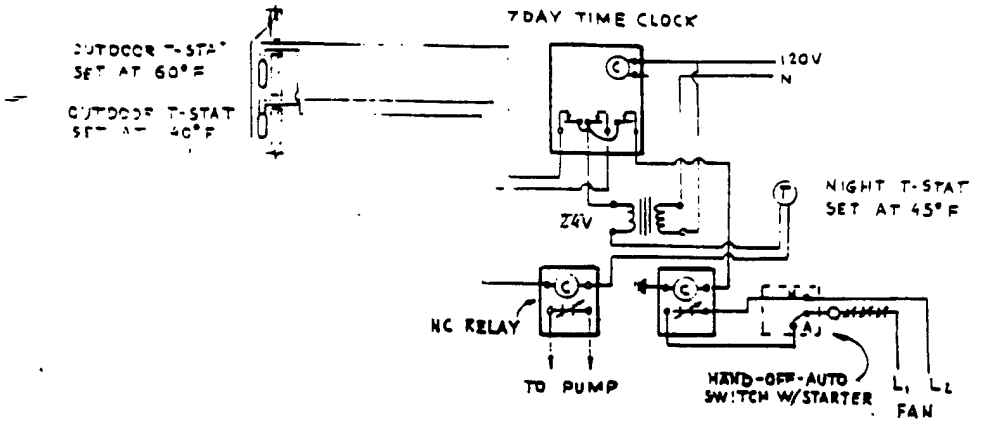
Arrangement #1: Hot water circulation pumps.
Arrangement #2: Pumps and fans for heating systems.
Arrangement #3: Fans for heating and cooling systems.

Time clock arrangement #1:



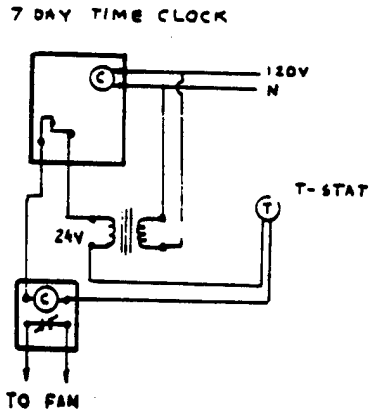
The time clock arrangement includes a seven day time clock and two outdoor air sensors. During occupied hours, as indexed by the time clock, the circulation pump operates when outside air temperature is below 60°F. During unoccupied hours the circulation pump operates below 50°F outside air temperature. A time of day thermostat will be installed in a central location and provide for stopping circulation pump when space temperature reaches 68°F during occupied hours and 55°F during unoccupied hours. The time clock will be indexed to the occupied cycle to one hour before building occupancy and indexed to unoccupied cycle one hour after normal building occupancy ends. When an unprogrammed occupancy occurs, the time clock will be overridden by an integral manual switch. The time clock also provides the heating control setting for Saturday and Sunday or other building occupancy schedules.

Time clock arrangement 2:



Time clock arrangement 2 is similar to arrangement 1 except two controllers (pump and fan) are connected to same time clock.

Time clock arrangement 3:



The time clock arrangement 3 is similar to arrangement 1 without outdoor thermostats. Savings resulting from any of the time clock controls reduction on steam and electrical consumption on the heating and A/C systems.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #48 - INSTALL TIME CLOCKS

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Reception Center	5656	10,374.6	$61,060	$7,004	15	1	10,376.6	$61,060	$7,004	0.1	89.87
Dental Clinic	5660	2,484.0	$12,495	$1,896	15	1	2,484.0	$12,495	$1,896	0.2	75.37
Admin/Storage	5917	484.5	$2,200	$1,064	15	5	2,422.5	$11,000	$5,320	0.5	24.80
Exchange Branch	5956	9.3	$52	$107	15	2	18.5	$103	$215	2.1	5.26
Total							15,299.6	$84,658	$14,434	0.2	62.72

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

GROUP 2

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Replace Lamps/Ballasts	41	16,915.0	$249,783	$218,810	0.9	13.93

41 INSTALL ENERGY EFFICIENT LAMPS/BALLASTS

Energy efficient 34 watt fluorescent tubes are available from several manufacturers which provide 6 watts per tube savings over the standard 40 watt fluorescent tube. It should be noted that the light output of 34 watt tubes is also reduced by approximately 15%. This however, is usually not noticeable and doesn't present a detriment in proposing the usage of energy efficient tubes. The replacement of 40 watt tubes with 34 watt tubes is only recommended on rapid start fixtures employing a high power factor ballast. Another consideration in retrofitting with 34 watt tubes is the ambient operating temperatures. Present design of 34 watt tubes restrict their use to temperatures above 60°F.

Energy savings ballasts are designed to perform the same function of the existing ballast, while minimizing losses. They can therefore be recommended in all retrofit applications, however, the cost of retrofitting fixtures with energy savings ballasts is prohibitive except replacement on an attrition basis. Energy savings ballasts can save approximately 10 watts on a two tube, 4 foot fixture.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #41 - REPLACE LAMPS/BALLASTS

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Enlisted Men's Mess Hall	5640	95.5	$990	$407	25	4	382.1	$3,960	$1,629	0.4	29.57
Enlisted Men's Mess Hall	5601	96.0	$1,017	$457	25	4	383.9	$4,068	$1,828	0.4	27.17
Enlisted Men's Mess Hall	5740	118.4	$1,267	$583	25	4	473.7	$5,068	$2,331	0.5	26.47
Water Filtration Plant	99	9.1	$92	$42	25	1	9.1	$92	$42	0.5	26.38
Battalion Headquarters	5605	106.9	$1,212	$660	25	5	534.5	$6,060	$3,300	0.5	22.41
Brigade Gym	5631	84.9	$1,097	$667	25	2	169.8	$2,194	$1,334	0.6	20.03
Red Cross	6051	22.2	$261	$169	25	1	22.2	$261	$169	0.7	18.26
Reception Center	5656	1,013.3	$12,502	$8,781	25	1	1,013.3	$12,502	$8,781	0.7	17.67
Sports Arena	6053	15.6	$188	$126	25	1	15.6	$188	$126	0.7	17.51
Enl. Mens Barracks	5515	105.7	$1,402	$1,026	25	5	528.5	$7,010	$5,130	0.7	16.65
Exchange Branch	5832	65.5	$873	$661	25	2	131.0	$1,746	$1,322	0.8	16.18
Brigade Gym	5731	10.9	$148	$112	25	2	21.8	$296	$225	0.8	16.02
BOQ	5254	7.1	$99	$79	25	2	14.2	$198	$158	0.8	15.27
Exchange Branch	5956	55.9	$805	$672	25	2	111.8	$1,610	$1,344	0.8	14.62
Enlisted Men's Mess Hall	5801	43.4	$628	$527	25	4	173.6	$2,512	$2,106	0.8	14.62
Brigade Chapel	5950	7.3	$117	$98	25	2	14.6	$234	$197	0.8	14.54
Enl. Men Barracks	5506	14.0	$217	$183	25	5	70.0	$1,085	$915	0.8	14.43
Enlisted Men's Barracks	5401	136.0	$2,011	$1,716	25	4	544.0	$8,044	$6,864	0.9	14.33
Enlisted Men's Barracks	5406	144.6	$2,355	$2,050	25	4	578.4	$9,420	$8,200	0.9	14.07
Enlisted Men's Barracks	5602	152.7	$2,316	$2,026	25	11	1,680.1	$25,476	$22,286	0.9	13.92
Brigade Classroom	5411	244.3	$3,855	$3,407	25	1	244.3	$3,855	$3,407	0.9	13.83
Indoor Swimming Pool	5901	25.6	$355	$309	25	1	25.6	$355	$309	0.9	13.80
Enlisted Men's Barracks	5910	161.2	$2,502	$2,234	25	10	1,611.7	$25,020	$22,340	0.9	13.65
Enlisted Men's Barracks	5702	161.2	$2,502	$2,234	25	11	1,772.8	$27,522	$24,574	0.9	13.65
Hangar	4433	17.8	$329	$289	25	5	89.0	$1,645	$1,444	0.9	13.60
Provost Marshall	5210	20.6	$366	$326	25	4	82.4	$1,464	$1,304	0.9	13.55
Main Chapel	5240	98.5	$1,612	$1,475	25	1	98.5	$1,612	$1,475	0.9	13.39
Enl. Men Barracks	5508	81.5	$1,300	$1,201	25	5	407.5	$6,500	$6,005	0.9	13.19
Bowling Alley	6054	34.2	$349	$316	25	1	34.2	$349	$316	0.9	13.18
Dispensary	5429	22.5	$353	$330	25	6	135.0	$2,118	$1,980	0.9	13.14
Enlisted Men's Barracks	5404	133.0	$2,146	$2,025	25	4	532.1	$8,584	$8,100	0.9	12.98
Admin/Storage	5713	68.2	$1,091	$1,033	25	5	341.0	$5,455	$5,165	1.0	12.96
Dental Clinic	5660	90.3	$1,484	$1,412	25	1	90.3	$1,484	$1,412	1.0	12.90
Admin/Storage	5643	79.3	$1,280	$1,218	25	5	396.5	$6,400	$6,088	1.0	12.84
DIO-CPO	6043	204.3	$3,165	$3,021	25	1	204.3	$3,165	$3,021	1.0	12.62
Admin/Storage	5917	32.0	$535	$520	25	5	159.9	$2,675	$2,598	1.0	12.62
Brigade/Classroom	5505	217.1	$3,616	$3,512	25	1	217.1	$3,616	$3,512	1.0	12.58
Battalion Headquarters	5805	41.8	$701	$688	25	6	251.0	$4,206	$4,128	1.0	12.50

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #41 - REPLACE LAMPS/BALLASTS

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
DEH Supply/NYCE	5317	56.2	$868	$843	25	2	108.4	$1,736	$1,686	1.0	12.47
DIO Administration	5418	307.0	$5,530	$5,479	25	1	307.0	$5,530	$5,479	1.0	12.37
Brigade Headquarters	5634	56.6	$962	$968	25	2	113.2	$1,924	$1,936	1.0	12.20
Battalion Headquarters	5734	69.2	$859	$878	25	3	147.6	$2,577	$2,633	1.0	11.97
Enlisted Men's Barracks	5802	147.9	$2,020	$2,046	25	11	1,626.4	$22,220	$22,506	1.0	11.96
Motor Repair Shop	5720	26.0	$416	$428	25	6	144.1	$2,496	$2,570	1.0	11.89
Battalion Headquarters	5614	46.8	$790	$817	25	5	233.8	$3,950	$4,085	1.0	11.88
Supply Serv. Admin	5211	27.7	$467	$477	25	5	138.5	$2,335	$2,385	1.0	11.81
DEH Admin Bldg	5320	64.2	$1,105	$1,159	25	1	64.2	$1,105	$1,159	1.0	11.50
NCO Open Mess	5455	25.8	$430	$464	25	1	25.8	$430	$464	1.1	11.37
Dental Clinic	5437	36.2	$623	$669	25	1	36.2	$623	$669	1.1	11.28
General Purpose Warehouse	3134	4.5	$79	$84	25	13	58.5	$1,027	$1,095	1.1	11.27
Community Service Center	6049	67.0	$1,179	$1,264	25	1	67.0	$1,179	$1,264	1.1	11.15
Transport Div	5139	141.8	$2,622	$2,901	25	1	141.8	$2,622	$2,901	1.1	10.91
Library	6501	34.7	$684	$794	25	1	34.7	$684	$794	1.2	10.40
Enl Men Ser Club	5756	77.4	$954	$1,215	25	1	77.4	$954	$1,215	1.3	9.75
Brigade Chapel	5635	4.1	$54	$70	25	2	8.2	$108	$140	1.3	9.52
General Purpose Warehouse	3129	1.3	$18	$28	25	13	16.9	$234	$365	1.6	7.61
Total							16,915.0	$249,783	$218,810	0.9	13.93

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

GROUP 3

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
CV to VAV	17	587.4	$4,430	$12,137	2.7	3.62
Zone Control	23	13,224.1	$85,889	$44,260	0.5	24.78
		13,811.5	$90,319	$56,397	0.6	20.23

OPERATION AND MAINTENANCE ITEMS

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Duct Insulation	1	4,041.7	$21,111	$39,141	1.9	8.93
Revise Boiler Controls	49	1,008.8	$6,906	$17,960	2.6	4.62
		5,050.5	$28,017	$57,102	2.0	7.57
TOTAL		18,862.0	$118,336	$113,499	1.0	13.86

1 DUCT INSULATION

Most of the buildings have heating and air conditioning systems with insulation missing on the outside, return and supply ducts and their components (plenums and enclosures). Uninsulated sheet metal duct with standard 2500 fpm air velocity loses approximately 0.7 BTU per hour per square foot of surface area. These heat losses can be reduced if commercially available insulation (2" thick fiberglass) is used. Insulation reduces heat gains or losses to approximately 0.2 BTU per hour per square foot of surface area.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #1 - DUCT INSULATION

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Battalion Headquarters	5605	90.0	$535	$501	25	5	450.1	$2,674	$2,507	0.9	15.87
OEM Supply/NYCE	5317	90.0	$618	$723	25	2	180.0	$1,236	$1,446	1.2	15.39
Dispensary	5429	90.9	$448	$592	25	6	545.3	$2,687	$3,551	1.3	12.86
Enlisted Men's Mess Hall	5640	74.5	$426	$517	25	4	297.8	$1,703	$2,066	1.2	12.59
Enl Men Ser Club	5756	208.8	$1,065	$1,402	25	1	208.8	$1,065	$1,402	1.3	12.59
Enlisted Men's Mess Hall	5601	156.9	$842	$1,179	25	4	627.6	$3,369	$4,718	1.4	11.41
Reception Center	5656	624.2	$2,835	$5,163	25	1	624.2	$2,835	$5,163	1.8	9.91
Enlisted Men's Mess Hall	5740	132.6	$655	$1,474	25	4	530.5	$2,620	$5,897	2.3	7.54
Exchange Branch	5956	49.1	$254	$737	25	2	98.3	$507	$1,474	2.9	5.65
Admin/Storage	5713	10.4	$50	$178	25	5	51.8	$252	$888	3.5	4.87
Admin/Storage	5917	9.8	$48	$178	25	5	48.8	$240	$888	3.7	4.60
Enlisted Men's Mess Hall	5801	72.0	$378	$1,622	25	4	288.0	$1,511	$6,487	4.3	3.78
Brigade Gym	5731	45.2	$205	$1,327	25	2	90.5	$411	$2,654	6.5	2.79
Total							4,041.7	$21,111	$39,141	1.9	8.93

17 CV TO VAV

The air handling units that were designed as constant volume systems serve the areas with varying occupancy and hours of operation. As a result, some of the rooms are overheated or overcooled. We recommend the installation of VAV diffusers equipped with built-in changeover thermal elements. Equip existing supply fans with variable speed drive and associated controls to modulate the system capacity according to the load in the control zones.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #17 - CONSTANT VOLUME TO VARIABLE AIR VOLUME

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Enl Men Ser Club	5756	587.4	$4,430	$12,137	15	1	587.4	$4,430	$12,137	2.7	3.62
Total							587.4	$4,430	$12,137	2.7	3.62

23 ZONE CONTROL

Some of the buildings have rooms or zones with different work activities or low density during occupied hours. The number of existing thermostats do not provide for control of the temperature in each of these zones.

We recommend the installation of additional thermostats, control valves or dampers to allow for equipment to be shut down or the temperature set back in unoccupied zones.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

$23 - ZONE CONTROL

Building Name	Building Number	ECO Number	Electric Fuel Savings (KWH)	Distillate Fuel Savings (Gallons)	Residual Fuel Savings (Gallons)	Annual Energy Savings (MBTU)	Annual Dollar Savings	Annual Non-Energy Savings Dollars	SPB	SIR	Cost y
Reception Center	5656	23	0	0	31,621	4,733.6	$32,420	$0	0.2	63.66	$6,116
General Purpose Warehouse	3129	23	(9,393)	3,112	0	322.7	$2,130	$0	0.4	32.60	$842
General Purpose Warehouse	3134	23	(15,655)	3,659	0	325.9	$2,100	$0	0.6	21.42	$1,324
Motor Repair Shop	5720	23	0	0	1,474	220.7	$1,002	$0	0.7	17.93	$670
Dispensary	5629	23	0	0	931	139.3	$633	$0	0.8	15.09	$502
Thrift Shop	3280	23	0	1,510	0	209.4	$1,434	$0	1.5	7.97	$2,160
Community Service Center	6049	23	0	3,009	0	417.3	$2,858	$0	1.7	7.19	$4,777
			(25,048)	11,290	34,026	6368.8	$42,577	$0	0.4	31.50	$16,392

49 REVISE BOILER CONTROLS

Flue gas and stack temperature analysis conducted on boilers and furnaces reveal that the O_2 or CO_2 concentrations vary from recommended for efficient combustion. Some boilers operate with 60-65% efficiency.

We recommend to rebuild and adjust the oil burners and also to install missing barometric dampers. In addition we recommend installation of flue dampers to prevent off-cycle stack losses.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #49 - REVISE BOILER CONTROLS

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Community Service Center	6049	119.1	$816	$150	15	1	119.1	$816	$150	0.2	65.10
Hanger	4433	177.9	$1,218	$3,562	15	5	889.7	$6,090	$17,810	2.9	4.11
Total							1,008.8	$6,906	$17,960	2.6	4.62

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

GROUP 4 OPERATION AND MAINTENANCE ITEM

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Piping Insulation	2	26,764.0	$126,579	$183,287	1.4	12.33
		26,764.0	$126,579	$183,287	1.4	12.33

2 INSULATION COVERS FOR PIPES, VALVES AND FLANGES

Most of the buildings have hot water and steam systems with insulation missing on pipes, valves and flanges.

Uninsulated pipes, valves and flanges with hot water (250°F), operating in 80°F environment lose approximately 290 BTU per hour per square foot of surface area. Uninsulated pipes, valves and flanges with steam (350°F) operating in the room, with 80°F surrounding temperature, lose approximately 640 BTU per hour per square foot of surface area. Those losses are a large contributor to mechanical room losses. Heat losses can be reduced if commercially available insulating covers are used. The insulating covers and jackets with 1" thick teflon fiberglass insulation reduce heat losses to approximately 45 BTU per hour per square foot for pipes, valves and flanges with hot water and to 85 BTU per hour per square foot for pipes, valves and flanges with steam.

The covers slip over the valves and flanges and are held in place with stainless steel clips. The cover can be removed if valve adjustment is necessary. Most of the hot water and steam pipes, valves and flanges that are presently used range in size from 1 to 4 inches.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #2 - PIPING INSULATION

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Nurse's Quarters	5256	184.3	$837	$1,439	25	3	552.9	$2,511	$4,317	1.7	10.50
Exchange Branch	5832	47.4	$215	$371	25	2	94.8	$431	$742	1.7	10.47
Admin/Storage	5713	79.1	$375	$633	25	5	395.6	$1,874	$3,164	1.7	10.36
Enl. Mens Barracks	5515	109.0	$495	$871	25	5	545.0	$2,475	$4,355	1.8	10.26
Reception Center	5656	699.4	$3,177	$6,197	25	1	699.4	$3,177	$6,197	2.0	9.25
Enlisted Men's Mess Hall	5801	147.1	$680	$1,354	25	4	588.4	$2,719	$5,416	2.0	8.94
Dispensary	5629	51.1	$241	$530	25	6	306.6	$1,447	$3,177	2.2	7.99
Exchange Branch	5956	71.2	$353	$943	25	2	142.4	$706	$1,886	2.7	6.79
Brigade Chapel	5635	3.4	$26	$59	25	2	6.8	$52	$118	2.3	5.55
DEH Supply/NYCE	5317	4.7	$36	$245	25	2	9.4	$72	$490	6.9	1.84
Total							26,766.0	$126,579	$183,287	1.4	12.33

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

GROUP 5

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Infrared Heating	27	650.0	$3,631	$25,649	7.1	1.68
Decentralized DHW	29	600.8	$4,553	$27,782	6.1	1.59
Lighting Controls	31	3,195.7	$26,108	$83,187	3.2	2.99
High Efficiency Motors	40	79.3	$601	$6,037	10.0	1.06
DHW Heat Pump	52	179.6	$1,362	$7,351	5.4	1.80
		4,705.4	$36,254	$150,006	4.1	2.37

OPERATION AND MAINTENANCE ITEMS

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Return Condensate	51	5,280.9	$24,095	$28,278	1.2	10.21
		5,280.9	$24,095	$28,278	1.2	10.21
TOTAL		9,986.3	$60,349	$178,284	3.0	3.61

27 INFRARED HEATERS

Heating in the warehouses buildings is provided by steam heating, ventilation units or unit heaters. Most of these areas are provided with entrance doors, shipping docks and gates. Due to the activity in these buildings these doors are used frequently, exposing the occupants to low temperature infiltrated air during the heating season. In these areas we recommend implementation of infrared heating. With infrared heating the comfort level could be achieved at air temperature of 50-55°F, thus reducing the required amount of energy.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #27 - INFRARED HEATING

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Transport Div	5139	650.0	$3,631	$25,649	25	1	650.0	$3,631	$25,649	7.1	1.68
Total							650.0	$3,631	$25,649	7.1	1.68

29 DECENTRALIZED DHW

Some of the buildings have electric domestic hot water heaters that are usually located in the mechanical rooms and supply hot water to the toilet rooms. These toilet rooms are located throughout the building and typically 150-200 feet away from the mechanical rooms. As a result, excessive heat losses from the distribution pipes occurs. We recommend a replacement of one large electric water heater with a number of smaller ones in order to minimize the distribution piping and associated losses of heat.

Expected savings:

Reduction of electric consumption.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #29 - DECENTRALIZED DHW

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Admin/Storage	5917	80.5	$610	$3,009	15	5	402.4	$3,049	$15,045	4.9	1.97
Admin/Storage	5713	39.7	$301	$2,548	15	5	198.4	$1,503	$12,738	8.5	1.15
							600.8	$4,553	$27,782	6.1	1.59
NOT RECOMMENDED PROJECTS											
Thrift Shop	3280	10.8	$82	$1,003	15	1	10.8	$82	$1,003	12.3	0.79
Admin/Storage	5643	22.4	$102	$2,548	15	5	111.9	$508	$12,738	25.1	0.48

31 INSTALL LIGHTING CONTROLS

The best way to save lighting energy is simply by shutting lights off when rooms are unoccupied. It is a prevalent belief that shutting lights off for short durations is not beneficial. Studies, however, have proven that although lamp life is reduced by switching often, there is an overall cost benefit to shutting lights off whenever they are not needed.

In order to achieve savings by shutting lights off, control must be provided. Lighting controls can vary from simply providing a switch, to computerized dimming devices.

Energy savings attributable to lighting controls is dependent upon how conscientious occupants are about shutting off lights. If lights are presently shut off whenever occupants leave, then automatic controls to accomplish the same thing is not cost effective. On the other hand, if occupants would not utilize localized lighting controls, then the only alternative is automatic control, such as motion sensors, time clocks, and photocells.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #31 - LIGHTING CONTROLS

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Thrift Shop	3280	108.7	$843	$347	15	1	108.7	$843	$347	0.4	22.42
Enlisted Men's Mess Hall	5640	137.7	$1,126	$596	15	4	550.8	$4,505	$2,383	0.5	17.89
Enl Men Ser Club	5756	56.1	$452	$361	15	1	56.1	$452	$361	0.8	12.02
Enl. Men Barracks	5508	75.9	$623	$903	15	5	379.5	$3,115	$4,515	1.5	6.59
NCO Open Mess	5455	6.4	$48	$83	15	1	6.4	$48	$83	1.7	5.66
Enlisted Men's Barracks	5406	92.6	$760	$1,626	15	4	370.5	$3,040	$6,504	2.1	4.47
DIO-CPO	6043	95.0	$738	$1,730	15	1	95.0	$738	$1,730	2.3	3.92
Enlisted Men's Barracks	5404	88.1	$723	$1,806	15	4	352.4	$2,893	$7,224	2.5	3.83
Community Service Center	6049	7.30	$50	161.00	15	1	7.3	$50	$161	3.21	3.74
Library	6501	19.9	$154	$391	15	1	19.9	$154	$391	2.5	3.66
Enlisted Men's Barracks	5401	73.3	$603	$1,596	15	4	293.2	$2,412	$6,384	2.6	3.61
Enl. Men Barracks	5506	31.8	$260	$903	15	5	159.0	$1,300	$4,515	3.5	2.76
Main Chapel	5240	42.4	$340	$1,445	15	1	42.4	$340	$1,445	4.3	2.26
Enlisted Men's Barracks	5702	17.4	$143	$1,084	15	11	191.6	$1,576	$11,924	7.6	1.26
Enlisted Men's Barracks	5910	17.4	$143	$1,084	15	10	174.2	$1,433	$10,840	7.6	1.26
Enlisted Men's Barracks	5802	17.4	$143	$1,084	15	11	191.6	$1,576	$11,924	7.6	1.26
Enlisted Men's Barracks	5602	17.3	$143	$1,084	15	11	190.3	$1,576	$11,924	7.6	1.26
Brigade Classroom	5411	6.9	$56	$532	15	1	6.9	$56	$532	9.5	1.01
Total							3,195.7	$26,108	$83,187	3.2	2.99

40 HIGH EFFICIENCY MOTOR

The existing heating, ventilation, air conditioning and exhaust systems are equipped with standard efficiency motors. The replacement of the existing motors with high efficiency motors offers a 2-8% efficiency improvement and associated electric energy savings.

The existing motors are in good operating condition. The replacement of the existing motors with high efficiency motors usually cannot be justified at this time due to high initial cost of the replacement. However, if any of the existing motors fails to operate and needs to be replaced, we recommend replacing them with high efficiency motors since an additional cost premium (approximately 50%) would have a pay back of 2-3 years.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #40 - HIGH EFFICIENCY MOTORS

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Indoor Swimming Pool	5901	18.9	$143	$1,224	15	1	18.9	$143	$1,224	7.5	1.29
Enl Men Ser Club	5756	37.3	$283	$3,111	15	1	37.3	$283	$3,111	9.5	1.01
Dental Clinic	5660	23.1	$175	$1,702	15	1	23.1	$175	$1,702	9.7	1.00
Total							79.3	$601	$6,037	10.0	1.06

51 RETURN CONDENSATE

The buildings that use high pressure steam for heating and ventilation are equipped with condensate return pumps. In some buildings the condensate return pumps leak or are in poor operating condition. As a result approximately 15-20% of the condensate is lost or wasted to the drain. We recommend to repair or replace the condensate return pumps that would allow for reduction in steam consumption.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #51 - RETURN CONDENSATE

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Enlisted Men's Barracks	5702	398.4	$1,810	$1,739	15	11	4,382.7	$19,906	$19,131	1.0	12.47
Brigade Gym	5731	119.4	$542	$883	15	2	238.7	$1,084	$1,765	1.6	7.36
Admin/Storage	5713	119.4	$542	$1,083	15	5	596.8	$2,711	$5,416	2.0	6.00
Transport Div	5139	17.1	$117	$371	15	1	17.1	$117	$371	3.2	3.79
Reception Center	5656	30.2	$207	$933	15	1	30.2	$207	$933	4.5	2.66
Battalion Headquarters	5734	5.2	$23	$221	15	3	15.5	$70	$662	9.4	1.27
Total							5,280.9	$24,095	$28,278	1.2	10.21

NOT RECOMMENDED PROJECTS

Enl Men Ser Club	5756	36.9	$168	$1,947	15	1	36.9	$168	$1,947	11.6	0.95
Brigade Chapel	5635	4.5	$20	$271	15	2	8.9	$41	$542	13.4	0.90
Nurse's Quarters	5256	3.8	$17	$552	15	3	11.4	$51	$1,656	32.0	0.35
Enlisted Men's Mess Hall	5740	5.2	$23	$883	15	4	20.6	$94	$3,530	37.7	0.32
Battalion Headquarters	5605	1.7	$8	$371	15	5	8.6	$39	$1,855	47.6	0.25

52 DOMESTIC HOT WATER HEAT PUMP

Heating in the majority of the 63 buildings included in this project is provided by high pressure steam from the central plant. Typically, high pressure steam enters the mechanical room and is converted to low pressure steam that is used for space heating and domestic hot water. Some of the buildings have individual steam or hot water boilers. During both the heating and cooling seasons, the temperature in the mechanical rooms is between 85°F and 100°F. The high mechanical room temperature is due to heat loss from valves, uninsulated flanges and bonnets, and inadequate insulation on the storage tanks, heat exchangers and pipe leads. Heat loss from the mechanical rooms of buildings supplied by the central plant ranges between 8 and 15 percent of the total heat energy distributed to this building. In buildings with individual boilers, heat losses range from 5 to 10 percent.

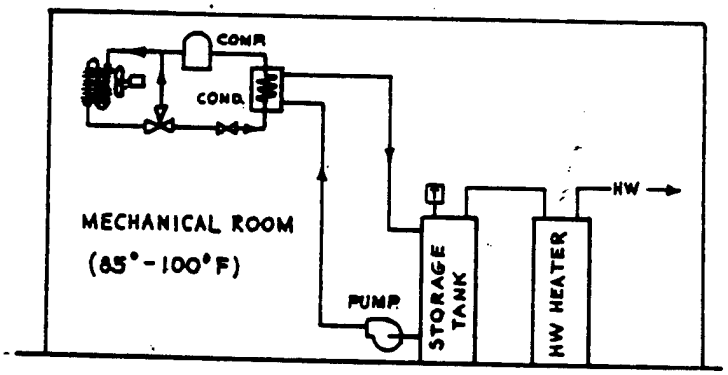
It is recommended that an air to water heat pump, storage tank (where required), and associated controls be installed to recover heat from the mechanical room and supply the recovered energy to the domestic hot water system.

At mechanical room temperatures between 85°F and 100°F, the heat pump will recover heat at a coefficient of performance (COP) approaching 2.0 to 3.0. In buildings with a domestic hot water load less than 100 gallons per hour, it is recommended that a 1 ton heat pump and 80 gallon storage tank be installed. Buildings with a domestic hot water load greater than 100 gallons per hour generally have a storage tank and the 1 ton heat pump can be hooked directly to this. Heat pump operation will be limited to occupied hours by a seven day time clock. Typically, the domestic hot water will be set at 105°F - 110°F.

Savings:

1. During the heating season, heat losses from mechanical room equipment, piping, etc. will be recovered and used to heat the domestic hot water supply. The existing electric hot water heater will not be required during this period and electric consumption will be reduced.

2. Additional electrical savings will be realized by reducing the domestic hot water temperature from between 120°F and 140°F to 105°F.



ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #52 - DHW HEAT PUMP

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
NCO Open Mess	5455	78.5	$595	$2,035	15	1	78.5	$595	$2,035	3.4	2.84
Bowling Alley	6054	55.0	$417	$2,332	15	1	55.0	$417	$2,332	5.6	1.74
Dental Clinic	5660	46.1	$350	$2,984	15	1	46.1	$350	$2,984	8.5	1.14
Total							179.6	$1,362	$7,351	5.4	1.80

NOT RECOMMENDED PROJECTS

DIO-CPO	6043	22.9	$174	$2,210	15	1	22.9	$174	$2,210	12.7	0.76
Enl Men Ser Club	5756	19.7	$149	$2,210	15	1	19.7	$149	$2,210	14.8	0.66
Brigade Classroom	5411	19.1	$145	$2,331	15	1	19.1	$145	$2,331	16.1	0.60
Brigade/Classroom	5505	13.8	$105	$2,034	15	1	13.8	$105	$2,034	19.4	0.50
DEH Admin Bldg	5320	14.0	$106	$2,332	15	1	14.0	$106	$2,332	22.0	0.44
Dental Clinic	5437	11.5	$87	$2,210	15	1	11.5	$87	$2,210	25.4	0.38
Battalion Headquarters	5805	11.5	$87	$2,331	15	6	69.2	$524	$13,985	26.7	0.36
Battalion Headquarters	5614	8.9	$68	$2,331	15	5	44.7	$338	$11,655	34.5	0.28
Battalion Headquarters	5605	8.9	$68	$2,331	15	5	44.7	$338	$11,655	34.5	0.28
Battalion Headquarters	5734	5.8	$44	$2,331	15	3	17.3	$131	$6,993	53.4	0.18

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

GROUP 6 (1)

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Radiator Control	45	10,696.5	$55,185	$122,124	2.2	5.16

GROUP 6 (2)

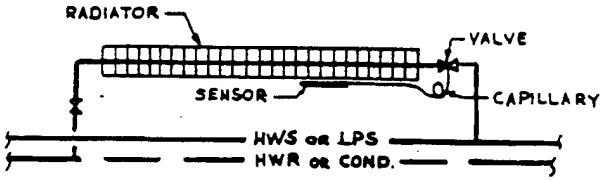
Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Radiator Control	45	12,542.2	$56,966	$173,125	3.0	3.76

GROUP 6 (3)

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Radiator Control	45	8,365.4	$38,060	$153,636	4.0	2.97

45 RADIATION CONTROL VALVES

Radiation in most facilities is oversized in that it was originally sized to match heat losses without credit for heat gains from people, sun and light. As a result, when there is no individual room control, the temperature in these rooms in uncomfortably warm and people are shutting of the radiator's manual valve or opening a window. The result is wasted energy, in that the radiator or fin tubes are emitting more heat than the minimum required to maintain comfortable room conditions.



Recommendation: Provide thermostatic control valves on each radiator (see diagram above). Each valve will be controlled by a room sensor and capillary, with bulb guard cover. The valves will also include an adjustable dial override. A locking handle will be a part of each valve to limit the amount of manual override based on room temperature.

Savings: Reduction on steam or hot water consumption. Energy savings is estimated at 15-20% per room. (Typical savings reported by manufacturers of such control valves)

For funding purposes this ECO was broken down into 3 subgroups. The first summary is for the entire facility. The following three summaries represent the subgroups.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #65 - RADIATOR CONTROL

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Transport Div	5139	79.5	$544	$562	15	1	79.5	$544	$562	1.0	11.64
Reception Center	5656	52.6	$239	$361	15	1	52.6	$239	$361	1.5	7.33
Thrift Shop	3280	89.4	$612	$1,083	15	1	89.4	$612	$1,083	1.8	6.79
Supply Serv. Admin	5211	205.1	$1,405	$3,011	15	5	1,025.5	$7,025	$15,055	2.1	5.60
DIO Administration	5418	3,651.8	$16,586	$33,116	15	1	3,651.8	$16,586	$33,116	2.0	5.55
DEH Admin Bldg	5320	139.7	$957	$2,107	15	1	139.7	$957	$2,107	2.2	5.45
Indoor Swimming Pool	5901	116.4	$797	$1,805	15	1	116.4	$797	$1,805	2.3	5.30
Nurse's Quarters	5256	997.2	$4,529	$9,634	15	3	2,991.6	$13,587	$28,902	2.1	5.21
Provost Marshall	5210	251.4	$1,722	$4,335	15	4	1,005.6	$6,888	$17,340	2.5	4.77
Community Service Center	6049	405.0	$2,774	$7,442	15	1	405.0	$2,774	$7,442	2.7	4.47
Enl. Men Barracks	5506	920.3	$4,180	$11,590	15	5	4,601.5	$20,900	$57,950	2.8	4.00
BOQ	5254	569.7	$2,588	$7,175	15	2	1,139.4	$5,176	$14,350	2.8	4.00
Enlisted Men's Barracks	5404	613.5	$2,787	$8,425	15	4	2,454.1	$11,147	$33,700	3.0	3.96
Motor Repair Shop	5720	28.5	$129	$421	15	6	170.9	$776	$2,527	3.3	3.68
Enlisted Men's Barracks	5401	771.3	$3,503	$10,597	15	4	3,085.2	$14,012	$42,388	3.0	3.67
NCO Open Mess	5455	112.3	$510	$1,656	15	1	112.3	$510	$1,656	3.2	3.42
Battalion Headquarters	5614	211.8	$962	$3,490	15	5	1,059.1	$4,810	$17,452	3.6	3.30
Battalion Headquarters	5605	211.8	$962	$3,490	15	5	1,059.1	$4,810	$17,452	3.6	3.30
Battalion Headquarters	5805	211.8	$962	$3,490	15	6	1,270.9	$5,772	$20,942	3.6	3.30
Enlisted Men's Mess Hall	5601	73.0	$332	$1,204	15	4	292.2	$1,327	$4,814	3.6	3.30
Admin/Storage	5643	255.6	$1,161	$4,212	15	5	1,278.2	$5,806	$21,062	3.6	3.30
Admin/Storage	5917	255.6	$1,161	$4,212	15	5	1,278.2	$5,806	$21,062	3.6	3.30
Enlisted Men's Barracks	5406	511.3	$2,322	$8,425	15	4	2,045.1	$9,289	$33,700	3.6	3.30
Enlisted Men's Mess Hall	5748	73.0	$332	$1,204	15	4	292.2	$1,327	$4,814	3.6	3.30
Enlisted Men's Mess Hall	5801	73.0	$332	$1,204	15	4	292.2	$1,327	$4,814	3.6	3.30
Brigade Headquarters	5634	95.0	$431	$1,565	15	2	189.9	$863	$3,129	3.6	3.30
Water Filtration Plant	99	27.9	$191	$723	15	1	27.9	$191	$723	3.8	3.18
Brigade Classroom	5411	204.5	$929	$4,212	15	1	204.5	$929	$4,212	4.5	2.64
Admin/Storage	5713	153.4	$697	$4,212	15	5	766.9	$3,483	$21,062	6.0	1.98
Enlisted Men's Mess Hall	5640	43.8	$199	$1,204	15	4	175.3	$796	$4,814	6.0	1.98
Battalion Headquarters	5734	40.2	$182	$1,324	15	3	120.5	$547	$3,972	7.3	1.65
Brigade/Classroom	5505	131.5	$597	$4,513	15	1	131.5	$597	$4,513	7.6	1.59
Total							31,604.1	$150,211	$448,884	3.0	3.87

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #45 - RADIATOR CONTROL (1)

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Transport Div	5139	79.5	$544	$562	15	1	79.5	$544	$562	1.0	11.64
Reception Center	5656	52.6	$239	$361	15	1	52.6	$239	$361	1.5	7.33
Thrift Shop	3280	89.4	$612	$1,083	15	1	89.4	$612	$1,083	1.8	6.79
Supply Serv. Admin	5211	205.1	$1,405	$3,011	15	5	1,025.5	$7,025	$15,055	2.1	5.60
DIO Administration	5418	3,651.8	$16,586	$33,116	15	1	3,651.8	$16,586	$33,116	2.0	5.55
DEH Admin Bldg	5320	139.7	$957	$2,107	15	1	139.7	$957	$2,107	2.2	5.45
Indoor Swimming Pool	5901	116.4	$797	$1,805	15	1	116.4	$797	$1,805	2.3	5.30
Nurse's Quarters	5256	997.2	$4,529	$9,634	15	3	2,991.6	$13,587	$28,902	2.1	5.21
Provost Marshall	5210	251.4	$1,722	$4,335	15	4	1,005.6	$6,888	$17,340	2.5	4.77
Community Service Center	6049	405.0	$2,774	$7,442	15	1	405.0	$2,774	$7,442	2.7	4.47
800	5254	569.7	$2,588	$7,175	15	2	1,139.4	$5,176	$14,350	2.8	4.00
Total							10,696.5	$55,185	$122,124	2.2	5.16

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #45 - RADIATOR CONTROL (2)

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Enl. Men Barracks	5506	920.3	$4,180	$11,590	15	5	4,601.5	$20,900	$57,950	2.8	4.00
Enlisted Men's Barracks	5404	613.5	$2,787	$8,425	15	4	2,454.1	$11,147	$33,700	3.0	3.96
Motor Repair Shop	5720	28.5	$129	$421	15	6	170.9	$776	$2,527	3.3	3.68
Enlisted Men's Barracks	5401	771.3	$3,503	$10,597	15	4	3,085.2	$14,012	$42,388	3.0	3.67
NCO Open Mess	5455	112.3	$510	$1,656	15	1	112.3	$510	$1,656	3.2	3.42
Battalion Headquarters	5614	211.8	$962	$3,490	15	5	1,059.1	$4,810	$17,452	3.6	3.30
Battalion Headquarters	5605	211.8	$962	$3,490	15	5	1,059.1	$4,810	$17,452	3.6	3.30
Total							12,542.2	$56,966	$173,125	3.0	3.76

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #45 - RADIATOR CONTROL (3)

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Battalion Headquarters	5805	211.8	$962	$3,490	15	6	1,270.9	$5,772	$20,942	3.6	3.30
Enlisted Men's Barracks	5406	511.3	$2,322	$8,425	15	4	2,045.1	$9,289	$33,700	3.6	3.30
Enlisted Men's Mess Hall	5601	73.0	$332	$1,204	15	4	292.2	$1,327	$4,814	3.6	3.30
Admin/Storage	5917	255.6	$1,161	$4,212	15	5	1,278.2	$5,806	$21,062	3.6	3.30
Admin/Storage	5643	255.6	$1,161	$4,212	15	5	1,278.2	$5,806	$21,062	3.6	3.30
Enlisted Men's Mess Hall	5740	73.0	$332	$1,204	15	4	292.2	$1,327	$4,814	3.6	3.30
Enlisted Men's Mess Hall	5801	73.0	$332	$1,204	15	4	292.2	$1,327	$4,814	3.6	3.30
Brigade Headquarters	5634	95.0	$431	$1,565	15	2	189.9	$863	$3,129	3.6	3.30
Water Filtration Plant	99	27.9	$191	$723	15	1	27.9	$191	$723	3.8	3.18
Brigade Classroom	5411	204.5	$929	$4,212	15	1	204.5	$929	$4,212	4.5	2.64
Admin/Storage	5713	153.4	$697	$4,212	15	5	766.9	$3,483	$21,062	6.0	1.98
Enlisted Men's Mess Hall	5640	43.8	$199	$1,204	15	4	175.3	$796	$4,814	6.0	1.98
Battalion Headquarters	5734	40.2	$182	$1,324	15	3	120.5	$547	$3,972	7.3	1.65
Brigade/Classroom	5505	131.5	$597	$4,513	15	1	131.5	$597	$4,513	7.6	1.59
Total							8,365.4	$38,060	$153,636	4.0	2.97

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

GROUP 7

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Replace Light Fixtures	37	7,205.8	$57,676	$186,962	3.2	5.37

37 REPLACE LIGHT FIXTURES

Selection of light source and fixture type is dependent upon many factors including level and quality of light required for the task being performed. For the purpose of the study, replacement of lighting fixtures is considered when a light source can be replaced with a more efficient source while achieving the same lighting levels.

Typical lighting system efficiencies for various types of lamps are as follows:

Lamp	Lumens/Watt
Incandescent	19
Mercury Vapor	57
Fluorescent	75
Metal Halide	100
High Pressure Sodium	125
Low Pressure Sodium	183

After selection of a light source, several affect the actual illumination reaching the work area such as fixture design, fixture and bulb cleanliness, color of interior spaces, and distance from light source.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #37 - REPLACE LIGHT FIXTURES

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Enl. Men Barracks	5508	180.2	$1,677	$1,114	25	5	901.0	$7,385	$5,570	0.5	22.79
Enlisted Men's Mess Hall	5801	68.8	$553	$542	25	4	275.3	$2,210	$2,166	0.7	16.85
Enl. Men Barracks	5506	191.0	$1,567	$1,686	25	5	955.0	$7,835	$8,430	0.8	15.87
General Purpose Warehouse	3134	139.8	$1,084	$1,588	25	13	1,817.0	$14,090	$20,640	0.9	12.43
Water Filtration Plant	99	103.6	$785	$1,726	25	1	103.6	$785	$1,726	1.9	6.85
Brigade Gym	5631	108.3	$883	$2,672	25	2	216.6	$1,767	$5,344	1.9	6.31
Brigade Chapel	5950	18.2	$146	$577	25	2	36.4	$292	$1,153	2.3	5.26
Nurse's Quarters	5256	1.7	$37	$723	25	3	5.1	$111	$2,169	2.2	5.18
Admin/Storage	5917	57.2	$458	$2,682	25	5	286.0	$2,291	$12,412	2.4	5.09
Motor Repair Shop	5720	63.9	$484	$1,360	25	6	383.3	$2,905	$8,160	3.2	4.15
Brigade/Classroom	5505	43.4	$353	$1,113	25	1	43.4	$353	$1,113	3.1	3.91
Enlisted Men's Mess Hall	5640	151.0	$1,227	$4,303	25	4	604.1	$4,907	$17,211	3.5	3.55
Community Service Center	6049	94.7	$738	$2,527	25	1	94.7	$738	$2,527	3.3	3.53
Sports Arena	6053	348.7	$2,706	$17,792	25	1	348.7	$2,706	$17,792	4.0	2.76
Dental Clinic	5437	23.2	$179	$1,214	25	1	23.2	$179	$1,214	5.2	2.37
DIO Administration	5418	29.7	$276	$1,545	25	1	29.7	$276	$1,545	5.6	2.31
Main Chapel	5240	51.6	$413	$3,532	25	1	51.6	$413	$3,532	5.5	2.29
Battalion Headquarters	5805	16.9	$136	$993	25	6	101.3	$817	$5,958	5.9	2.17
Enl. Mens Barracks	5515	33.7	$274	$2,287	25	5	168.5	$1,370	$11,435	5.5	2.16
Brigade Gym	5731	27.9	$228	$1,510	25	2	55.7	$456	$3,021	6.0	2.13
Brigade Classroom	5411	339.0	$2,763	$44,234	25	1	339.0	$2,763	$44,234	8.9	1.33
Brigade Gym	5731	154.9	$1,286	$2,617	25	2	309.7	$2,572	$5,233	1.6	7.71
Main Chapel	5240	56.8	$455	$4,375	25	1	56.8	$455	$4,375	5.8	2.17
Total							7,205.8	$57,676	$186,962	3.2	5.37

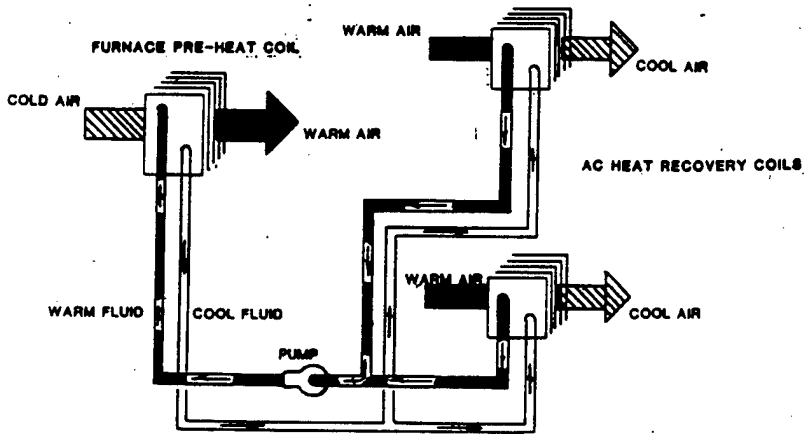
ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

GROUP 8

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Heat Recovery	24	299.2	$2,030	$15,448	7.6	1.61
Kitchen Hood Control	25	9,095.8	$46,742	$129,985	2.8	4.07
Control HW Circ. Pump	43	280.2	$2,124	$6,919	3.3	3.01
Destratification	47	474.4	$2,558	$30,654	12.0	1.96
		10,149.6	$53,454	$183,006	3.4	3.47

ECO #24 - Heat Recovery System

Computer equipment generates a great deal of heat while being very temperature sensitive. In large computer installations it is necessary to provide air conditioning year round to maintain cool operating temperatures. Currently in these buildings the rejected computer room heat is lost to the outside, while other zones in the building may require heat. The overall evergy efficiency can be improved through the use of a glycol loop heat recovery system. Here heat rejected from the computer room air conditioning would be recaptured by a second coil. The glycol heated in the recovery coil would then be pumped to a preheat coil in the furnace intake duct.



SCHEMATIC GLYCOL LOOP HEAT RECOVERY

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #24 - HEAT RECOVERY

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
DEH Supply/NYCE	5317	149.6	$1,015	$7,724	15	2	299.2	$2,030	$15,448	7.6	1.61
Total							299.2	$2,030	$15,448	7.6	1.61

LOW SPEED HOOD EXHAUST

The kitchen load varies throughout the day depending on the number of the people served and meals scheduled. The existing kitchen hoods are equipped with exhaust fans which operate 24 hours a day. These fans are equipped with constant speed motors. The full capacity of the exhaust fans is required only when extensive cooking occurs. It is recommended two speed fan motors and remote controls for exhaust hood ventilators be installed in order to allow kitchen personnel to match the ventilation capacity with kitchen load.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #25 - KITCHEN HOOD CONTROL

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Enlisted Men's Mess Hall	5760	609.6	$3,251	$8,124	15	4	2,438.3	$13,003	$32,496	2.5	4.46
Enlisted Men's Mess Hall	5601	609.6	$3,251	$8,124	15	4	2,438.3	$13,003	$32,496	2.5	4.46
Enlisted Men's Mess Hall	5640	529.9	$2,611	$8,124	15	4	2,119.6	$10,444	$32,496	3.1	3.71
Enlisted Men's Mess Hall	5801	524.9	$2,573	$8,124	15	4	2,099.6	$10,292	$32,496	3.2	3.66
Total							9,095.8	$46,742	$129,985	2.8	4.07

ECO #43 - Control HW Circulation Pump

Reduction of pump energy and conduction losses to domestic hot water pipes can be achieved by shutting off the circulation pump during periods when the building is unoccupied. It is recommended that a seven-day time clock be connected to the circulation pump to match the occupancy schedule.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #43 - CONTROL HW CIRCULATING PUMP

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
DIO-CPO	6043	48.6	$368	$461	15	1	48.6	$368	$461	1.3	7.77
Admin/Storage	5713	29.0	$220	$461	15	5	145.2	$1,101	$2,307	2.1	4.63
Enl Men Ser Club	5756	15.8	$120	$461	15	1	15.8	$120	$461	3.8	2.53
Dispensary	5429	9.4	$71	$461	15	6	56.2	$426	$2,768	6.5	1.50
Sports Arena	6053	7.1	$54	$461	25	1	7.1	$54	$461	8.6	1.48
Transport Div	5139	7.2	$55	$461	15	1	7.2	$55	$461	8.4	1.15
							280.2	$2,124	$6,919	3.3	3.01
NOT RECOMMENDED PROJECTS											
Dental Clinic	5437	4.8	$36	$461	15	1	4.8	$36	$461	12.7	0.77
Admin/Storage	5917	4.7	$36	$461	15	5	23.4	$178	$2,307	13.0	0.75
Admin/Storage	5643	3.0	$23	$461	15	5	15.2	$115	$2,307	20.0	0.48
Enl. Mens Barracks	5515	2.0	$15	$461	15	5	10.0	$75	$2,305	30.4	0.32
Enlisted Men's Mess Hall	5601	1.6	$12	$460	15	4	6.3	$48	$1,841	38.5	0.25
Enlisted Men's Mess Hall	5801	1.3	$10	$460	15	4	5.2	$40	$1,841	46.3	0.21

47 DESTRATIFICATION

Several buildings have very high ceilings. Lowering of the ceiling may be precluded by either function or architectural aesthetics. Heat naturally rises and the air near the floor will be cooler than that near the ceiling. When the ceiling is high a great deal of energy is wasted as the strata near the ceiling reach very high temperatures while maintaining a comfortable temperature in the lower occupied zone.

It is recommended that destratification fans be installed near the ceilings of these buildings. The function of these fans would be to drive the warmer upper air back toward the occupied zone.

Savings: A reduction on heating demand and resultant fuel savings.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #47 - DESTRATIFICATION

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Hangar	4433	64.8	$402	$4,716	25	5	324.0	$2,010	$23,580	11.7	2.05
Brigade Chapel	5950	52.7	$188	$2,358	25	2	105.4	$376	$4,716	12.5	1.73
Main Chapel	5240	45.0	$172	$2,358	25	1	45.0	$172	$2,358	13.7	1.50
							474.4	$2,558	$30,654	12.0	1.96

NOT RECOMMENDED PROJECTS

NCO Open Mess	5455	20.1	$39	$2,689	25	1	20.1	$39	$2,689	68.3	0.23
Brigade Chapel	5635	5.6	($9)	$2,358	15	2	11.2	($18)	$4,716	-248.8	0.01

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

GROUP 9

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Ceiling Insulation	12	8,707.6	$50,487	$201,363	4.0	4.52

12 CEILING INSULATION

Transmission losses generally can be reduced through the addition of insulation to ceilings. The amount of heat gain or heat loss caused by transmission depends on the difference between indoor and outdoor temperatures according to the basic principles of heat flow. During winter, heat flows from the interior through the building envelope to the exterior, causing heat loss. In the summer, the process reverses and heat is transmitted from outside to inside, causing a heat gain.

It is recommended that fiberglass batt insulation be installed above existing ceilings. In most cases, ceiling insulation will require a vapor barrier placed on the warm side of the ceiling, if not integral with the insulation, to prevent structural damage caused by rot, corrosion or expansion of freezing water.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #12 - CEILING INSULATION

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Admin/Storage	5643	426.1	$1,935	$2,957	25	5	2,130.4	$9,676	$14,784	1.5	11.81
DIO-CPO	6043	939.2	$6,443	$10,332	25	1	939.2	$6,443	$10,332	1.6	11.23
Community Service Center	6049	528.6	$3,620	$6,305	25	1	528.6	$3,620	$6,305	1.7	10.39
Transport Div	5139	166.2	$1,138	$2,291	25	1	166.2	$1,138	$2,291	1.7	9.00
Thrift Shop	3280	171.5	$1,174	$3,200	25	1	171.5	$1,174	$3,200	2.7	6.64
NCO Open Mess	5455	525.6	$2,444	$7,975	25	1	525.6	$2,444	$7,975	3.1	5.44
DIO Administration	5418	672.9	$3,056	$12,764	25	1	672.9	$3,056	$12,764	4.0	4.32
Library	6501	202.0	$1,383	$5,920	25	1	202.0	$1,383	$5,920	4.1	4.23
DEH Admin Bldg	5320	47.4	$325	$1,644	25	1	47.4	$325	$1,644	5.0	3.58
General Purpose Warehouse	3134	95.5	$654	$3,520	25	13	1,241.0	$8,500	$45,766	5.4	3.36
Bowling Alley	6054	227.9	$1,570	$8,679	25	1	227.9	$1,570	$8,679	5.5	3.21
General Purpose Warehouse	3129	89.8	$615	$3,625	25	13	1,167.5	$7,996	$47,122	5.9	3.07
Enlisted Men's Mess Hall	5640	91.1	$424	$4,629	25	4	364.6	$1,695	$17,716	10.5	1.70
Brigade Gym	5631	80.7	$367	$4,216	25	2	161.4	$733	$8,433	11.5	1.57
Brigade Gym	5731	80.7	$367	$4,216	25	2	161.4	$733	$8,433	11.5	1.57
Total							8,707.6	$50,487	$201,363	4.0	4.52

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

GROUP 10

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Inside Insulation	10	1,052.5	$7,209	$88,110	12.2	1.48
Reduction of Glass Area	36	334.2	$1,537	$4,942	3.2	5.61
		1,386.7	$8,745	$93,052	15.4	7.1

OPERATION AND MAINTENANCE ITEMS

Energy Saving Opportunity	ECO Number	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Personnel Door Weatherstrip	7	1,415.5	$6,806	$36,950	5.4	1.75
Reduce Infiltration	46	928.7	$4,267	$42,410	9.9	1.31
		2,344.2	$11,073	$79,360	15.4	3.1
TOTAL		3,730.9	$19,819	$172,412	8.7	1.62

7 PERSONNEL DOOR WEATHERSTRIPPING

Unwanted outside air infiltrates into a building through inadvertent openings in the building envelope, open doors, etc. Since outdoor air, regardless of source, must be heated or cooled (and sometimes humidified and/or dehumidified), infiltration imposes a significant load on the heating and cooling system, increasing total energy consumption. It is recommended that worn or broken weatherstripping on personnel doors be replaced. Weatherstripping should also be installed where none has previously been installed.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #7 - PERSONNEL DOOR WEATHERSTRIPPING

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Bowling Alley	6054	9.9	$70	$213	25	1	9.9	$70	$213	6.2	4.30
DIO-CPO	6043	20.3	$141	$554	25	1	20.3	$141	$554	10.6	3.09
Enlisted Men's Mess Hall	5640	13.5	$64	$298	25	4	53.9	$254	$1,192	7.5	2.97
Reception Center	5656	40.4	$183	$937	25	1	40.4	$183	$937	27.5	2.02
Enl. Men Barracks	5506	28.9	$131	$617	25	5	144.5	$655	$3,085	18.8	2.01
Enl. Men Barracks	5508	28.9	$131	$617	25	5	144.5	$655	$3,085	18.8	2.01
Enlisted Men's Barracks	5404	28.9	$131	$617	25	4	115.5	$525	$2,467	18.8	2.00
Brigade Chapel	5635	33.5	$157	$723	25	2	66.9	$313	$1,446	17.5	1.99
Brigade Chapel	5950	31.8	$161	$723	25	2	63.7	$322	$1,446	15.9	1.88
Enlisted Men's Mess Hall	5801	13.3	$62	$298	25	4	53.2	$249	$1,192	20.1	1.86
Exchange Branch	5956	20.2	$96	$468	25	2	40.3	$192	$937	21.8	1.74
Battalion Headquarters	5805	19.2	$90	$447	25	6	115.1	$543	$2,684	23.4	1.72
Battalion Headquarters	5605	19.1	$90	$447	25	5	95.7	$450	$2,237	23.9	1.70
Brigade Headquarters	5634	8.9	$42	$213	25	2	17.8	$84	$425	25.9	1.63
Enl. Mens Barracks	5515	20.7	$94	$617	25	5	103.5	$470	$3,085	(143.2)	1.53
Enlisted Men's Barracks	5406	21.1	$96	$617	25	4	84.4	$383	$2,467	(241.8)	1.46
Transport Div	5139	13.2	$90	$767	25	1	13.2	$90	$767	(24.6)	1.46
Enlisted Men's Barracks	5401	20.0	$91	$617	25	4	80.2	$363	$2,468	(84.1)	1.39
NCO Open Mess	5455	18.4	$87	$638	25	1	18.4	$87	$638	(45.0)	1.30
Supply Serv. Admin	5211	13.9	$95	$725	25	5	69.7	$477	$3,625	(36.1)	1.29
Admin/Storage	5643	8.0	$36	$213	25	5	39.8	$181	$1,063	95.9	1.23
Exchange Branch	5832	12.3	$59	$468	25	2	24.6	$117	$937	(29.2)	1.06
Total							1,415.5	$6,806	$36,950	5.4	1.75

10 INSIDE INSULATION

Transmission losses generally can be reduced through the addition of insulation to walls. The amount of heat gain or heat loss caused by transmission depends on the difference between indoor and outdoor temperatures according to the basic principles of heat flow. During winter, heat flows from the interior through the building envelope to the exterior, causing heat loss. In the summer, the process reverses and heat is transmitted from outside to inside, causing a heat gain.

It is recommended that fiberglass batt insulation be installed on the interior of the walls between the wood studs and covered with ½" sheet rock on the interior. Where the inside wall is in place it is recommended that the insulation be blown in.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #10 - INSIDE INSULATION

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
Hangar	4433	91.4	$626	$3,611	25	5	456.8	$3,128	$18,053	5.8	3.14
General Purpose Warehouse	3129	45.8	$314	$5,389	25	13	595.7	$4,080	$70,057	17.1	1.06
Total							1,052.5	$7,209	$88,110	12.2	1.48

36 REDUCTION OF GLASS AREA

Heat loss through the attic is a major contributor to heating loads. This heat loss can be reduced if the overall thermal resistance of the attic can be improved. The single pane glass (presently used in the attic) provides very little thermal resistance. If these windows are not needed to provide day-lighting it is recommended they be covered with rigid insulation and sheet rock from the inside.
Expected savings:

Reduced heating loads and resultant steam energy savings.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #36 - REDUCE GLASS AREA

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
DIO-CPO	6043	8.0	$55	$85	25	1	8.0	$55	$85	1.5	11.59
Brigade/Classroom	5505	326.2	$1,482	$4,857	25	1	326.2	$1,482	$4,857	3.2	5.50
Total							334.2	$1,537	$4,942	3.2	5.61

46 REDUCE INFILTRATION

The heating (or cooling) of unnecessary unconditioned outside air is a major factor in the overall HVAC load for many buildings. To reduce the infiltration of unwanted outside air it is recommended that the cracks around door and window frames and piping penetrations be sealed with caulking. Additionally individual room air conditioning units should be sealed with appropriate covers during the heating season.

Expected savings:

Reduction of net HVAC load and resulting fuel savings.

ECO SUMMARY TABLE
ENERGY SAVINGS OPPORTUNITY SURVEY
FORT DIX, NEW JERSEY

ECO #46 - REDUCE INFILTRATION

Building Name	Building Number	Annual Energy Savings (MBTU)	Annual Energy Dollar Savings	Cost	Life Years	No. of Typical Buildings	Base Total Annual Energy Savings (MBTU)	Base Total Annual Energy Dollar Savings	Base Total Cost	SPB	SIR
DEH Admin Bldg	5320	6.8	$47	$201	25	1	6.8	$47	$201	3.8	4.43
Water Filtration Plant	99	14.5	$99	$411	25	1	14.5	$99	$411	4.2	4.36
Enlisted Men's Barracks	5702	81.6	$371	$3,750	25	11	897.9	$4,078	$41,251	17.0	1.27
Main Chapel	5240	9.5	$43	$547	25	1	9.5	$43	$547	24.0	1.09
Total							928.7	$4,267	$42,410	9.9	1.31

Ft. Dix

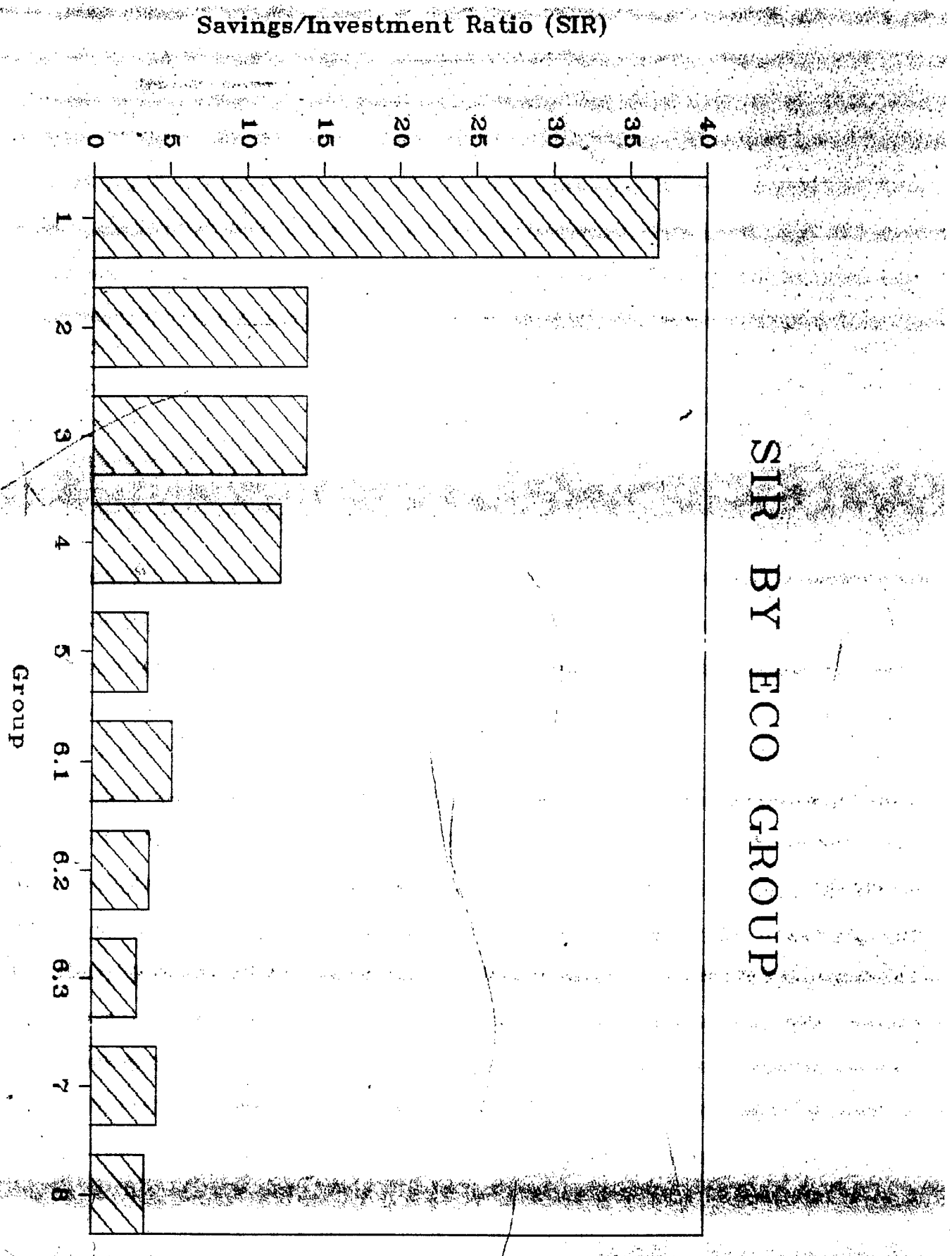
Building OTTV

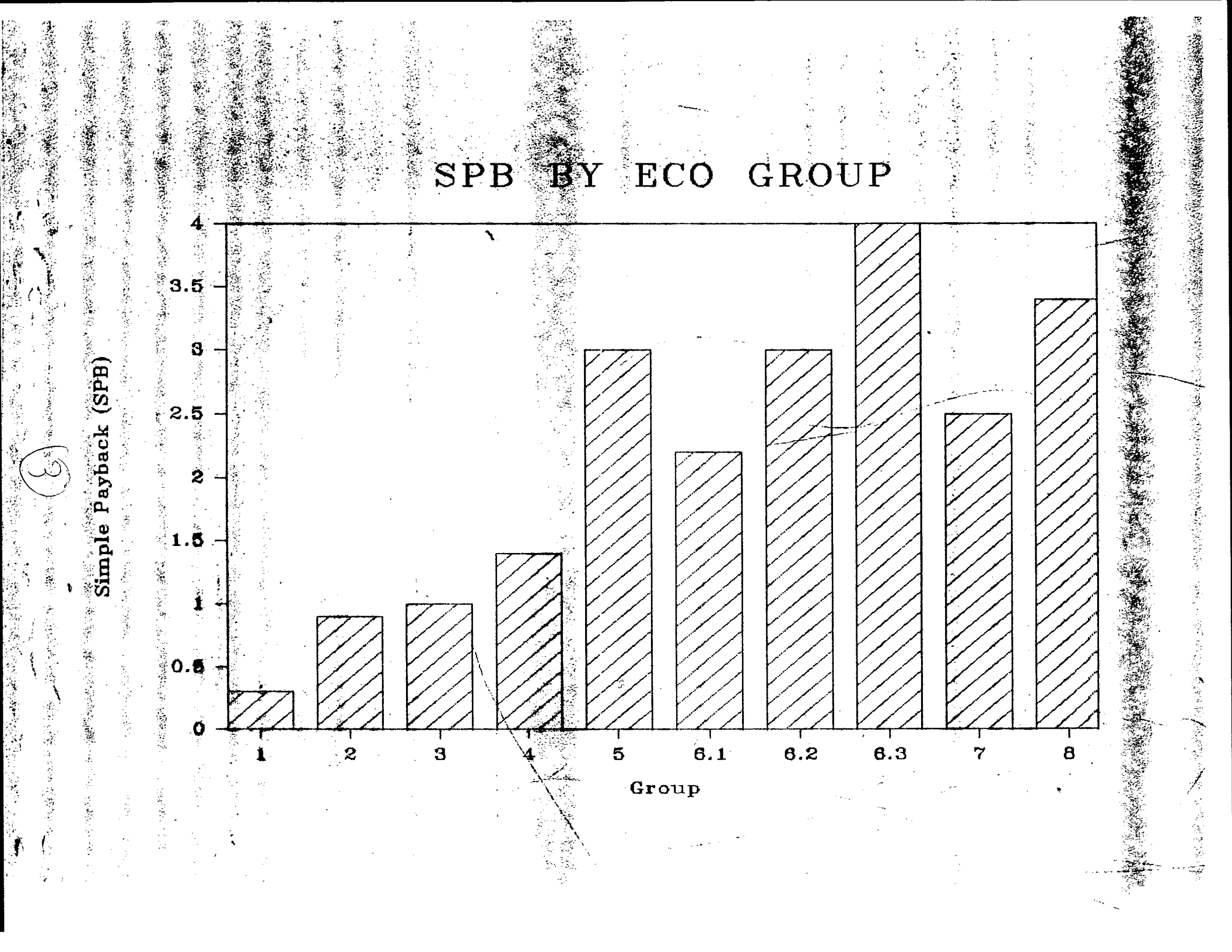
Btu/hr-sf-deg

0.7 0.6 0.5 0.4 0.3 0.2 0.1 0

Building

5317 6051 5740 5601 5640 5801 6054 5210 5211 5429 5320 5515 5506 5508 6501 5401 5404 5406 5605 5616 5805 3280 3129 5256 5254 5411 5505 5455 6053 5240 6043 5656 5832 5956 5731 5631 5756 6049 3134 99 5635 5950 4433 5437 5702 5602 5802 5910 5418 5901 5713 5917 5643 5139 5634 5734 5668 5720


Savings/Investment Ratio (SIR)
0
5
10
15
20
25
30
35
40
Group
1
2
3
4
5
6.1
6.2
6.3
7
8
SIR BY ECO GROUP


SPB BY ECO GROUP
Simple Payback (SPB)
4
3.5
3
2.5
2
1.5
1
0.5
0
1
2
3
4
5
6.1
6.2
6.3
7
8
Group